IAG

EUROPEAN REGIONAL GEOMORPHOLOGICAL CONFERENCE

HUNGARY

April 9 - 12, 1996

PROGRAMME

ABSTRACTS

PARTICIPANTS

GEOMORPHOLOGY AND THE CHANGING ENVIRONMENT IN EUROPE

GEOMORPHOLOGY AND THE CHANGING ENVIRONMENT IN EUROPE

EUROPEAN REGIONAL CONFERENCE
organised by the
INTERNATIONAL ASSOCIATION OF GEOMORPHOLOGISTS
(IAG)

Hungarian Academy of Sciences
Budapest, 9-12 April, 1996

Conference programme
Abstracts of papers
List of participants

edited by

Dénes **Lóczy**
László **Bassa**

BUDAPEST
1996

Technical Board:

László Bassa
Dénes Lóczy
Pál Müller

Published and copyright by the
Geographical Research Institute
Hungarian Academy of Sciences
Budapest

ISBN 963 7395 73 3

Printed by
CIER PRINT Bt. Budapest

CONFERENCE PROGRAMME

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Conference programme

8 April, 1996, Monday

Arrival of participants in Budapest, hotel rooms to be occupied after 12.00.
Airport Minibus service is available from air terminals to hotels.

19.00 Welcome drink in Hotel MEDOSZ (Budapest, Jókai tér 9.)

9 April, Tuesday

8.30-10.00 Registration in the Main Building, Hungarian Academy of Sciences (Budapest, Roosevelt tér 9.)

Opening ceremony and plenary session (Main Building of the Academy)

Welcome addresses

10.00-10.10 Welcome address by Prof Dr **Ernő Mészáros**, president, Department of Geosciences, Hungarian Academy of Sciences
10.10-10.20 Address by Prof Dr **Olav Slaymaker** (Vice-President, International Association of Geomorphologists)

Keynote lectures

10.20-10.50 Prof Dr **Márton Pécsi**: Evolution of geomorphological surfaces in the Transdanubian Mountains, Hungary
10.50-11.20 Prof Dr **Victor Baker**: Geomorphology and global habitability
11.20-11.50 Prof Dr **Jaromír Demek**: Environmental change in Central Europe

12.40 Buffet lunch and refreshments on Danube boat anchored at the Main Building of the Academy
14.00 *Guided tour:* Urban geomorphology of Budapest
led by Prof Dr Márton PÉCSI and Prof Dr Ferenc SCHWEITZER
(Geographical Research Inst. Hung. Academy of Sciences)
Price: DEM 20 (not included in registration fee)
ca 17.00 Tour ends: Geographical Research Institute (Budapest, Andrássy út 62.)
Accommodation in Budapest

10 April , Wednesday

8.00-11.30 *Travel by bus to Veszprém* (110 km), stops and explanations at various sites on the way

12.00 Lunch

Paper sessions (Regional Committee of Hungarian Academy of Sciences, Veszprém, Vár utca 37. and Veszprém Inst. of College for State Administration, Veszprém, Vár utca 39.

A1 Fluvial geomorphology 1
Chair: Janet HOOKE, Portsmouth

13.00-13.20 STARKEL, Leszek, Cracow: The Vistulian-Holocene cycle in the evolution of Carpathian valleys
13.20-13.40 HAGEDORN, Jürgen, Göttingen: Holocene floodplain evolution along the middle and upper courses of small rivers, Lower Saxony, Germany
13.40-14.00 QIAO Pengnian, Guangzhou: Fluvial processes in the Pearl River Delta
14.00-14.20 CHAI Fuxiang, Guangzhou: The submerged Zhujiang delta
14.20-14.40 VANMAERCKE-GOTTIGNY, Marie Christine, Leuven-Brussel: Valley floor morphology and lithology as indicators of Late Pleistocene climatic changes

15.00-15.20 Coffee break

A2 Fluvial geomorphology 2
Chair: Jürgen HAGEDORN, Göttingen

15.20-15.40 GAMS, Ivan, Ljubljana: Chemical denudation as a geomorphic process
15.40-16.00 HOOKE, Janet, Portsmouth: Riffle stability in relation to meander forms and processes
16.00-16.20 KALVODA, Jan, and BALATKA, Břetislav, Prague: Origin of the Labe valley in the Dečínska vrchovina
16.40-17.00 PALOTÁS, Klára, Budapest: Tectonics and geomorphology or: Are the streams flowing in the right direction?

B1 Long-term geomorphic evolution
Chair: Márton PÉCSI, Budapest

13.00-13.20 HAAS, János, KOVÁCS, Sándor, HÁMOR, Géza, Budapest, and SZEDERKÉNYI, Tibor, Szeged: Structural evolution of the Pannonian region in the last 500 million years
13.20-13.40 PÜSPÖKI, Zoltán and PÜSKI, Imre, Debrecen: Morphogenetic research on a Jurassic surface, SW Bükk Mts, Hungary
13.40-14.00 KIRCHNER, Karel, and IVAN, Antonin, Brno: Granite landforms in the Dyje and Brno Massifs on the SE margin of the Bohemian massif
14.00-14.20 GÉCZI, Róbert, Szeged: Geomorphological surfaces in the Transylvanian Central Mountains
14.20-14.40 PRELOGOVIĆ, Eduard, BOGNAR, Andrija and MIHLJEVIĆ, Darko, Zagreb: Geomorphological evidence of neotectonic activity in NW-Croatia
14.40-15.00 URBÁNEK, Jan, Bratislava: Tectonic landforms in the Malé Karpaty Mts, Slovakia

15.00-15.20 Coffee break

B2 Nature conservation and environmental protection

Chair: Ion MAC, Cluj

15.20-15.40 PINCZÉS, Zoltán, Debrecen: Conservation of natural and anthropogenic landscapes: Example of the Tokaj Mts, N-Hungary

15.40-16.00 KISS, Gábor, Debrecen: Nature conservation oriented evaluation of geomorphological features

16.00-16.20 KERÉNYI, Attila, and SZABÓ, György, Debrecen: The role of morphology in environmental pollution

16.20-16.40 FODOR, István, Pécs: Environmental hazards in S-Transdanubia

16.40-17.00 CSÜLLÖG, Gábor, and MÓGA, János, Budapest: Morphological, hydrological and ecological investigations in the S-Gömör-Torna karst region

C1 Quaternary landscape evolution

Chair: Kazimierz KLIMEK, Sosnowiec

13.00-13.20 CSERNY, Tibor, and BODOR-NAGY, Elvira, Budapest: Pre-Quaternary morphology and Quaternary evolution of Lake Balaton

13.20-13.40 SÜMEGI, Pál, Debrecen et al.: Morphogenetic research of a late Quaternary wetland, NE-Hungary

13.40-14.00 ČESNULEVIČIUS, Algimantas, Vilnius: Quantitative characteristics of the glacial relief in Lithuania

14.00-14.20 SÜMEGI, Pál, Debrecen et al.: Paleoecological research of the loess on Kopasz Hill, Tokaj Mts, N-Hungary

14.20-14.40 KIS, Éva, Budapest: Comparison of loess types in Hungary using granulometry

14.40-15.00 KOTARBA, Adam, Cracow: Environmental changes on the Pleistocene/Holocene boundary in the High Tatras, Poland

15.00-15.20 Coffee break

C2 Recent geomorphic processes

Chair: Adam KOTARBA, Cracow

15.20-15.40 TARNÓCAI, Charles, Ottawa, and SCHWEITZER, Ferenc, Budapest: Cryogenic features in Canada and Hungary and their significance for past climate

15.40-16.00 PINCZÉS, Zoltán, Debrecen: Actual periglacial processes in Hungary

16.00-16.20 RĄCZKOWSKA, Zofia, Cracow: The geomorphic role of snow patches in the High Tatras, Poland

16.20-16.40 FÜKÖH, Levente, Gyöngyös: Biostratigraphic and geomorphic investigations in areas of Hungary subsided during the Holocene

Poster session (Veszprém Branch, Hungarian Academy of Sciences, Veszprém)

17.00-18.00

BALLA, Zoltán, Budapest: On the tectonic control of earthquakes in Hungary

BALLA, Zoltán, and DUDKO, Antonina, Budapest: Faults in the Pannonian sequences of Hungary

BALOGH, János, Budapest: Blake paleomagnetic event in three loess profiles

BARTA, Károly, and TARNAI, Tamás, Szeged: Karst geomorphology in the Mecsek Mts, S-Hungary

BRACMAN, Pascal, DE DAPPER, Morgan, Gent, and PENA-MONNE, José-Luis, Zaragoza: False-colour composites and geomorphological mapping

HUSZÁR, Tamás, KERTÉSZ, Ádám and SZALAI, László, Budapest: Soil erosion mapping through GIS and remote sensing

LANGOHR, Roger, and BECZE-DEÁK, Judit, Gent: Soils and climate change reflected by alluvial soil-sedimentary complex

CZIGÁNY, Szabolcs, Pécs: Loess in the Mecsek Mts, S-Transdanubia

DOBOS, Anna, Debrecen: Periglacial features in the Bükk Mts, N-Hungary

FÁBIÁN, Szabolcs, KOVÁCS, János and VARGA, Gábor, Pécs: Sand wedges in the Carpathian Basin

FAJER, Maria, Sosnowiec: Fe precipitation in alluvia, S-Poland

FRÖHLICH, Jochen, and DRÄYER, Dietrich, Basel: GIS-based erosion model

HEVESI, Attila, Miskolc: Karst geomorphological mapping and paleohydrographic conclusion, Bükk Mts

HORVÁTH, Erzsébet, Budapest: Tephra in young loess, Hungary

HORVÁTH, Erzsébet, GÁBRIS, Gyula, Budapest, and FRECHEN, Manfred, Cologne: TL dating of loess in Hungary

HORVÁTH, Gergely, Budapest: Relief types of county Nógrád, N-Hungary

HUM, László, Szeged: Geochemistry of loess in S-Transdanubia, Hungary

JAKUBSKA, Oleksa: Mantle rock slopes in the Polish Tatras

JUHÁSZ, Ágoston, Budapest: Landslides and climate in the Holocene

JUHÁSZ, Ágoston, and MAROSI, Sándor, Budapest: Soil erosion in type localities on the Lake Balaton catchment

KAISER, Miklós, Budapest: Geomorphic evolution of Transdanubian Mts

KALICKI, Tomasz, Cracow: Late Glacial-Holocene evolution of the Vistula valley

KIRCHNER, Karel, and NOVÁČEK, Vítězslav, Brno: Changes of the Morava river bed, S-Moravia

LÓCZY, Dénes, SZALAI, László, Budapest, and SZABÓ, Lajos, Gödöllő: Land capability and landscape sensitivity in a sand region of Hungary

LOVÁSZ, György, and NAGYVÁRADI, László, Pécs: Geomorphology and urban development, Komló, S-Transdanubia, Hungary

MAKÁDI, Mariann, Budapest: Paleogeographical reconstruction from molluscs

MARI, László, Budapest: Geomorphology of the Szentendre Island

MAROSI, Sándor, Budapest: Evolution of Lake Balaton

NAGY, Balázs, Budapest: Glacial features in the Carpathians

PARK, S.J. and BURT, Tim P., Oxford: Soil property variations on a 3-D slope

SZALAI, Zoltán, Budapest: Soil and vegetation pattern on Háros Island, Budapest

SZATMÁRI, József, Szeged: Field mesurements of soil removal by wind

VEKERDY, Zoltán, Enschede, and KLINGHAMMER, István, Budapest:

WILHELM, Zoltán, Pécs: Engineering geomorphology and urban development

ZÁMBÓ, László, Budapest: Monitoring karstwater infiltration

20.00 Reception offered by the Mayor of Veszprém (Town Hall, Óváros tér 9.)
Accommodation in Veszprém

April 11th Thursday

Full-day excursion: Bakony Mountains and Balaton Uplands

8.00 Bus departs from Veszprém

topics: Karst, buried paleokarst features, tectonic basins, pediments, buried and exhumed planation surfaces, Neogene basaltic landforms (basalt-capped residual hills, maars), formation of marine platforms. Geochronology of surfaces, geomorphological, land use and environmental protection issues.

route: Veszprém - Nagyvázsony - Pula - Nyirád - Darvastó - Uzsabánya - Tapolca Basin - Kál Basin - Tihany - Tótvázsony - Veszprém

Pocket lunch

April 12th Friday

Morning paper sessions

A3 Geomorphological hazards 1

Chair: Carlo ELMI, Bologna

9.00-9.20	SLAYMAKER, Olav, Vancouver: Geomorphological hazards
9.20-9.40	BISCI, Carlo, and BRUNI, Francesco, Camerino et al.: Slope instability mapping using GIS techniques: an example in Central Italy
9.40-10.00	BAJGIER-KOWALSKA, Małgorżata, Cracow: Dynamics of landslide development in the Flysch Carpathians during rapid rainfalls and floods
10.00-10.20	HRÁDEK, Mojmír, Brno: Origin of valleys at the E margin of the Bohemian Massif and their natural hazards
10.20-10.40	GRECU, Floare, and BENEA, Ionel, Bucharest: Geographical hazards within morphohydrographic basins

10.40-11.00 Break

A4 Geomorphological hazards 2

Chair: Olav SLAYMAKER, Vancouver

11.00-11.20	SCHMIDT, Karl-Heinz, Halle: Mass movements on the Muschelkalk scarp in central Germany
11.20-11.40	IELENICZ, Mihai, Bucharest *et al.*: Slope evolution systems in the Curvature Subcarpathians
11.40-12.00	SZABÓ, József, Debrecen: Spatial order of landslide processes in Hungary
12.00-12.20	VILÍMEK, Vít, Prague: Geomorphological aspects of Huascarán rockfalls, Peru

B3 Karst geomorphology

Chair: Ivan GAMS, Ljubljana

8.40-9.00	JUHÁSZ, Ágoston, Budapest: Karstic relief generations in the Bakony Mts, W-Hungary
9.00-9.20	CSILLAG, Gábor, and NÁDOR, Annamária, Budapest: Geomorphology and karstification in the Keszthely Mts, W-Hungary
9.20-9.40	ZÁMBÓ, László, Budapest: Karst denudation calculated from karst morphologhical soil influence
9.40-10.00	GÉCZY, Gábor, Budapest et al.: Air circulation in karst regions traced by natural radon
10.00-10.20	KEVEI-BÁRÁNY, Ilona, Szeged: Tectonic and geomorphic evolution of the Bükk Mts, N-Hungary, with special regard to doline formation
10.20-10.40	KORPÁS, László, Budapest: Geological models of paleokarst systems: Theory and applications
10.40-11.00	VERESS, Márton, and KADARKAI, Sándor, Szombathely: Karst processes in the N-Bakony Mts

11.00-11.20 Break

B4 Volcanic landforms

Chair: Ion MAC, Cluj

11.20-11.40	SZÉKELY, András, Budapest: Geomorphology of Neogene volcanic mountains in Hungary
11.40-12.00	NÉMETH, Károly, Budapest: Tihany volcano as a complex phreatomagmatic volcano
12.00-12.20	LACIKA, Jan, Bratislava: Basalt surfaces in the Slovak Carpathians
12.20-12.40	KARÁTSON, Dávid, Budapest: Volcanological and morphological features of Miocene pyroclastic flow deposits in Hungary

C3 Basin evolution

Chair: Andrija BOGNAR, Zagreb

9.00-9.20	BAUMGART-KOTARBA, Maria, Cracow: Tectonic evolution of the Orawa Basin, Carpathians
9.20-9.40	KORPÁS-HÓDI, Margit, and BOHN-HAVAS, Margit, Budapest: Miocene evolution of the Pannonian Basin
9.40-10.00	MÜLLER, Pál, and MAGYAR, Imre, Budapest: Late Miocene evolution of the Pannonian Lake
10.00-10.20	SCHWEITZER, Ferenc, Budapest: On a semidesert/desert climate in the Carpathian Basin during the Late Miocene and Early Pliocene

10.20-11.00 Break

C4 Geomorphology and development

Chair: Morgan DE DAPPER, Gent

11.00-11.20	BALLA, Zoltán, Budapest, *et al.*: Neotectonics of the Paks area, S-Hungary
11.20-11.40	MAC, Ion, Cluj: Geomorphological aspects of regional planning: example of the Apuşeni Mts, Romania
11.40-12.00	POSEA, Grigore, Bucharest: Geographical Studies for systematisation and regional planning: example of the Romanian Plain
12.00-12.20	RÉTVÁRI, László, and TÓZSA, István, Budapest: Impact of bauxite mining on environmental management
12.20-12.40	YATSUKHNO, Valentin, and SHISHONOK, Nikolai, Minsk: Geomorphology, urban water protection and recreation zones: the case of Minsk, Belarus

D1 Soil erosion

Chair: John BOARDMAN, Oxford

9.00-9.20	INBAR, Moshe, Haifa: Erosion of field terraces in mountains
9.20-9.40	RICHTER, Gerold, Trier, and KERTÉSZ, Ádám, Budapest: Soil erosion in the Lake Balaton region
9.40-10.00	STANKOVIANSKY, Miloš, Bratislava: Surface runoff in the Myjava Hills, Slovakia
10.00-10.20	MEZŐSI, Gábor, Szeged: The predicted wind erosion rate in the Carpathian Basin
10.20-10.40	HACHINOHE, Shoichi, Tokyo, et al.: Slaking susceptibility of rocks and hoodoo formation in the Drumheller Badlands, Alberta, Canada

Afternoon paper sessions

A5 Human impact on rivers

Chair: Victor R. BAKER, Tucson

14.00-14.20	KLIMEK, Kazimierz, Sosnowiec: Alluvial deposits in Upper Silesia as an indicator of human pressure during the last millennium
14.20-14.40	CISZEWSKI, Dariusz, Cracow: Fluvial processes and the dispersal and storage of metals in polluted rivers, Upper Silesia
14.40-15.00	KOCEL, Krystyna, Sosnowiec: The impact of ponds on the geochemical properties of alluvial deposits in S-Upper Silesia
15.00-15.20	RAKONCZAI, János, Szeged: Some recent impacts of river regulation and land drainage in the Great Hungarian Plain
15.20-15.40	LÓCZY, Dénes, Budapest: Human impact on rivers in Hungary as reflected by changes in channel planform

15.40-16.00 Coffee break

16.00-16.20	GAZDA, László, and MUCSI, László, Szeged: History of human impact on the geomorphology of the S Tisza valley, Hungary
16.20-16.40	ZIĘTARA, Tadeusz, Cracow: Prognoses and rapid changes of the Carpathian relief during disastrous floods of the last 50 years

B5 Climate change
Chair: Ádám KERTÉSZ, Budapest

14.00-14.20 BOARDMAN, John, and FAVIS-MORTLOCK, David, Oxford: Implications of climate and land use change for soil erosion in the UK
14.20-14.40 HUANG, Zhenguo, Guangzhou: On the lowest sea level during the culmination of the late glacial in S-China
14.40-15.00 MOLNÁR, Katalin, and MIKA, János, Budapest: Regional features of global climatic change on the landscapes of Hungary
15.00-15.20 SPASSKAYA, Irina, Moscow: Geomorphic response to short-term climatic changes
15.20-15.40

15.40-16.00 Coffee break

16.00-16.20 MOLNÁR, Béla, Szeged: Chemistry and recharge of lakes on the Danube-Tisza Interfluve, Hungary
16.20-16.40 ZHANG, Weiqiang, Guangzhou: Change in natural zonation as reflected by the evolution of red earth in China

C5 Geomorphological and geoecological mapping
Chair: Gábor MEZŐSI, Szeged

14.00-14.20 KLINGHAMMER, István, and GERCSÁK, Gábor, Budapest: Geography, remote sensing and mapping
14.20-14.40 JUHÁSZ, Ágoston, Budapest: Geoecological investigation and mapping of areas in environmental crisis in Hungary
14.40-15.00 HORVÁTH, Erzsébet, MARI, László, and NEMERKÉNYI, Antal, Budapest: Land cover and geomorphological units of Hungary: A special investigation of the CORINE project
15.00-15.20 BRACMAN, Pascal, DE DAPPER, Morgan, Gent and PENA-MONNE, Zaragoza: False-colour composites derived from DEM variables as a tool for geomorphological mapping and interpretation
15.20-15.40 KARANCSI, Zoltán, and MUCSI, László, Szeged: Landscape ecological studies in the Medves region, N-Hungary

18.00 Farewell party

ABSTRACTS OF PAPERS

DYNAMICS OF LANDSLIDE DEVELOPMENT IN THE FLYSCH CARPATHIANS DURING RAPID RAINFALLS AND FLOODS

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The role of landslides in changing the slopes of the Flysch-Carpathians is significant though they shape only limited parts of the slopes. These are areas in which more than half of the slopes have been modelled by deep rock debris slumps. Landslide dating is very difficult for movements develop in stages. The age of deep Carpathian landslides is related to the end of the last Glacial or to an early phase of the Holocene climatic optimum. Landslides also occurred at the beginning of the Atlantic phase and in the middle Holocene. There were periods of intense landslide activities in historical times, notably in the 14th, 15th, at the end of the 17th and at the beginning of the 18th centuries.

Present changes due to landslides and the expansion of the affected area take place in stages what means that there are periods if intense processes caused by rapid rainfalls and long periods of stability between them. Such rapid rainfalls occurred in 1958, 1960, 1970 and 1980 when landslide processes had been intensified. The threshold of slope stability was exceeded in these years and landslide modelling was differentiated and conditioned by different rhythm of precipitation and slope wetness before rapid rainfalls. In 1958 older slumps were dissected by erosional processes, and in 1960 the landslides were rejuvenated upon their surfaces. New deep rockslides were also created. In 1980 large areas of debris landslides formed in which descendant movements took place for many years. During small or medium floods (1959, 1972) the threshold of slope stability was not exceeded and landslides formed sporadically.

Wide dislocational zones in the Flysch-Carpathians are not very stable, so the formation of deep landslides can probably be associated with rejuvenated dislocations. The impulses causing landslide formation in these zones are seismic tremors in the neighbouring regions, e.g. in the Romanian Carpathians. When the period of weak reflection of tremor is proceeded by wet period, rejuveantion of landslides may occur. Such landslides took place in the Beskid Niski (1957) and in the Beskid Śląski (1990). This development is gradual and the Carpathian landslides consist of rock debris masses of various age with their fragments being in different stages of evolution.

GEOMORPHOLOGY AND GLOBAL HABITABILITY

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Much current global change and natural hazard research is of limited value because of an overemphasis on prediction through idealized conceptual models predicated upon unverifed assumptions. To understand environmental change one needs scientific experience of such change as a complement to the conceptualization of that change. Geomorphology, a major science of natural experience, has largely been marginalized by the value systems imposed by the earthsystem science emphasis of modern global change research.

Current intemational science initiatives to understand global change focus on prediction achieved through mathematical models. It is assumed that this approach will provide the essential basis for policy- and decision-making to mitigate threats to global habitability. Because such models are strictly unverifiable in the real world, accurate foreknowledge of the future is an impossible goal. As a practical matter, decisions will be made on the basis of perception, grounded in the available experience of change. The greatest repository of Earth experience capable of stimulating human perception is the Earth's surface and evidence of its geomorphological change. In studying this record, geomorphologists employ synthetic reasoning, using retroductive (causal) inference, to interpret indices (signs) of processes that reveal the natural patterns (habits) of Earth experience through time and space. Discovery of anomalous phenomena leads to the need for revising prior conceptualizations (models), refomulating them to be more in accord with reality. An example is the recent discovery in tropical river paleoflood records that large floods may be preferentially clustered in recent decades. If corroborated by further study, this may indicate an influence of global greenhouse warming on monsoonal circulation and tropical storms. Such change could have profound implications for global habitability.

ON THE TECTONIC CONTROL OF EARTHQUAKES IN HUNGARY

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Most of Hungarian geomorphologists and geologists claim that parallel or quasi-parallel NW-SE to NE-SW valleys of Hungary follow Quaternary faults. On the other hand, tectonic control of earthquakes is hardly debatable. The amount of "fault-related" valleys is very significant (at least the half of Transdanubia is full of them) whereas seismicity of Hungary is low.

An analysis of criteria and data for tectonic control of valleys revealed that the idea had been born over 80 years ago but has been never and nowhere confirmed by direct observations. Thus, the idea in question should be regarded a working hypothesis that is not necessarily true.

The principal idea in analyzing earthquake distribution in Hungary was that tectonic control can be only discussed for epicentral zones, not for single epicenters, as is frequent in Hungary, especially among geomorphologists. The only obvious epicentral zone in the neighbourhood of Hungary is the Mur-Mürz zone in Austria and Slovakia, its width being of about 20-50 km. From here, the minimum size of epicentral zones to be searched for in Hungary has been chosen as 20 km in width and 40 km in length.

Most of Hungarian earthquakes $I_o \geq 5$ (MSK-64) fall within 17 zones or ellipsoidal spots. Twelve of them can be related to various lineaments, mostly of tectonic origin. Eight of those twelve are striking in a WSW-ENE direction that is the main structural trend in Hungary, five of them being concentrated around the tectonic axis of the country. Two more zones are of SW-NE and one more is of W-E orientation, *i.e.*, also close to the main structural trend. A conclusion can be drawn: most of the earthquakes in Hungary reflect the general SW-NE structural trend and are not connected with the prevailing valley pattern.

NEOTECTONICS OF THE PAKS AREA (SOUTH HUNGARY)

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Evaluation of the seismic hazard for the Paks Nuclear Power Plant (N.P.P.) is based on the integrated interpretation of geological, geomorphic, remote sensing and geophysical data. Former attempts resulted in conclusion that all the data point to Quaternary activity of two systems of faults trending in northwest-southeast and southwest-northeast directions. The N.P.P. is situated above a cross point of two main faults, *ie.* its seismic hazard is rather high.

Detailed studies in 1994-95 resulted in significant changes in perception of the seismic hazard. It became clear that the resolution of geological and geomorphic maps as well as geoelectrical sections is too low for tracing young faults. Interpretation of remote sensing data and lithoclase measurements resulted in abundant lineaments concentrated around NW-SE and SW-NE directions but distributed with no concentration above, *ie.* no connection with faults in underlying Pannonian sediments.

High resolution seismic sections display the lower third or half of the Quaternary sequence. The basis of the Quaternary is not obvious in the sections although it is very sharp in a lithologic sense. The reflector pattern of the Quaternary is difficult to interpret in terms of fluvial structures, thus, it is hard to accept as the correct image of the stratification. Vertical transparent zones are crossing both the Pannonian and Quaternary sequences. In the first seismic section that detected them, a zone of this type was located above faults in the underlying Pannonian and was interpreted in terms of a very young tectonic zone. From subsequent sections it became clear that transparent zones in maps do not follow faults in Pannonian and that some of them are not connected with any faults in Pannonian. Technical expertise revealed that they are probably due to various noises during recording and processing. Some aspects of the generation of the transparent zones and some details of the Quaternary reflector pattern have not been fully cleared up, *ie.* further investigations are needed. As a general consequence, it can be stated that the neotectonic activity in the surroundings of Paks has not been confirmed and the seismic hazard is lower than is was assumed before.

FAULTS IN THE PANNONIAN SEQUENCES OF HUNGARY

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Geomorphology is usually believed to be under strong influence of neotectonics, in a closer approximation, of young faults. Faults in Quaternary of Hungary are mostly distinguished and traced from various geomorphic criteria but are scarcely visible. From a geological viewpoint, faults in Quaternary should be rejuvenated faults in underlying Pannonian (Upper Miocene through, according to some scientists, Pliocene) sequences. Therefore, it is of certain interest from a geomorphic point of view what are faults in the Pannonian.

A database of the faults observed in Pannonian sequences of Hungary was completed by reviewing the geological literature and receiving data from experts. Faults with observable offsets (331) only were taken into account, and that was the first summary of the faults in Pannonian sequences of Hungary. In the map, 120 exposures in 114 points were displayed, most of them located in Transdanubia. Faults striking in NW-SE and SE-NW directions are dominant, many faults are oriented nearly N-S, but fault directions within the quadrant with an E-W axis are almost absent. Normal faults are most frequent, transcurrent faults are scarce, reverse faults only occur in the zone of the Sub-Mecsek Line in Southwest Hungary. Geomorphic lineaments (*eg.,* valleys) in Hungary mostly fall within the quadrant with a N-S axis as well; in that sense they can reflect rejuvenation of faults in the Pannonian sequences. On the other hand, direct relation of geomorphic lineaments to faults in the Pannonian sequences needs more detailed investigations.

KARST GEOMORPHOLOGY ON THE CATCHMENT OF THE VIZFŐ SPRING, ORFŰ, MECSEK MOUNTAINS, HUNGARY

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For one and a half year research has been conducted to confirm the existence of a cave system of several kilometre length beyond the most abundant spring of the karst of the Western Mecsek, the Vízfő spring. Attempts have been made to find the optimal site for opening an entrance to the cave.
The present poster is meant to show the methods and achievements of preliminary geomorphological and hydrological field surveys, which were preceded by a thorough study of literature. Parallel to clearing the entrance to the cave, observations of karst processes and features were also made. The poster presents the findings concerning the impacts of young tectonic movements on the extension and links of the catchment area, the communication between surface and underground water-courses and cave formation.
The work is to be continued with the exploration of the Szuadó Cave, whose length is 145 m at present.

TECTONIC EVOLUTION OF THE ORAWA BASIN (CARPATHIANS)

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The intramontane Orawa Basin was formed at the boundary of the Inner and Outer Carpathians. The first period of basin formation during the Neogene (Upper Badenian to Pontian) is represented by fluvial, mainly floodplain/backswamp series up to 950 m thick. The second tectonic phase is documented in the Wróblówka Depression infilled with 112 m thick Quaternary deposits. Late Pliocene (after Dacian) was presumably characterised by a general uplift and start of the erosional history of the Orawa Basin. Less resistant Neogene sediments were eroded and removed by the Orawa River, then a tributary of the Váh (Danube catchment). During the Quaternary the western part of the Orawa Basin experienced an uplift and a system of cut-and-fill terraces formed. The northeastern part of the Orawa Basin represents flat relief of fluvioglacial/alluvial Late Glacial and Holocene fan of the Czarny Dunajec River flowing presently to the Dunajec River (Vistula catchment).
Formerly, the Orawa Basin was conceived a depression of synclinal type (HALICKI 1930, KLIMASZEWSKI 1953, 1988, WATYCHA 1976, 1977). According to KSIĄŻKIEWICZ (1972), the Orawa Basin is a subsided depression bordered by faults. For its genesis the pull-apart theory can be adopted. A megalineament is clearly traceable on the satellite images and stretches as a sinistral strike-slip fault system along the elongated Domanski Wierch (hills) stretching northeast on the eastern boundary of the basin and built of apron-type Pliocene molasse. To the north it proceeds in the unusually large Lepietnica valley. BAC-MOSZASZWILI (1993) interpreted this zone with the Krowiarki fault as a very young tectonic line (Rhodanian tectonic phase). This lineament named as the Prosecno dislocation system (NEMCOK 1993). According to POSPIŠIL (1990, 1993), the Orawa depression is a pull-apart basin but is not connected with the Choc-Western Tatra lineament or Myjawa lineament. POSPIŠIL (1993) demonstrates dextral system of strip-like faults and the Orawa Basin being connected with faults bordering partly the Klippen Belt at the east of Zazriva sigmoid. According to BAC-MOSZASZWILI (1993) the opening of the Orawa Basin during the Styrian phase was associated with a sinistral strike-strip fault controlled with the Parnica (Zazriva) sigmoid formation. BAC-MOSZASZWILI assumes a change of strike-slip motion during the Late Pleistocene for a dextral one.
Author claims that the Prosecno tectonic line is a sinistral fault zone of rather oblique character; a strike slipe-slip fault between the uplifted Tatras and Podhale blocks shifted to northeast and rotated to northwest Magura Orawska blocks including Skoroszyna Central Flysch, Klippen Belt and Magura Outer Flysch east of Zazriva sigmoid. The opening of the Orawa Basin can be put to the end of the Badenian (Serravalin) ca. 14 Ma BP. The young Quaternary accretion of the northeastern part of the Orawa Basin may have been caused by progressive subsidence in northeastern direction.

SLOPE INSTABILITY MAPPING USING GIS TECHNIQUES: AN EXAMPLE IN CENTRAL ITALY

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The authors present a GIS application (ILWIS) aimed at the evaluation and mapping of geomorphological hazards, and particularly slope instability, under static conditions.
To this end, detailed geoogical, geomorphological and hydrogeological field surveys have been carried out along a portion of the eastern foothills of the Umbro-Marchean Apennines (Central Italy) where slope instability phenomena of different types are particularly frequent on the Pliocene (predominantly clayey and subordinately arenaceous-conglomeratic) surfaces.
The various information layers deriving from field observations were used as a basis for statistical analyses. The combination of inhomogeneous data was carried out adopting the "favourability function approach" proposed by CHUNG and FABBRI (1993), using batch files to run the sequence calculation and crossing facilities of ILWIS. The adopted methodology is based on the statistical analysis of spatial distribution and concomitance of the predisposing and triggering factors which caused mass movements in the area. This kind of analysis is not suitable for exact evaluations but can give a reliable overview of the general morphodynamic trends characterising the study area, which is particularly useful for land use planning.
As a result three raster maps were produced showing hazard prediction for flows, soil creeps and badlands (translational and rotational slides were surveyed and mapped but were not included in the analyses since they are not common in the area). In each of these maps, data deriving from statistical analyses were classified into six classes of progressively growing Certainty Factors (CF) for the considered phenomenon. Most of the area occurred to be prone to slope instability, and only a few portions could be regarded as safe from geomorphological hazard.
In order to allow a better understanding of the above maps, mostly for territorial managers not familiar with traditional maps, three dimensional representations of the area were produced. The colour maps indicating the hazard zonation were used as a basis with changing the tones of the basic colours attributed to the different CF classes according to the grey-tone shadowing, for the sake of a better visualisation of relief.

IMPLICATIONS OF CLIMATE AND LAND USE CHANGE FOR SOIL EROSION IN THE UK

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Future climate in southern England may be wetter in the winter, drier in the summer, but with increased probability of summer thunderstorms. This scenario has implications for soil erosion, and off-site flooding and pollution.
Climate change will demand that farmers make choices between crops such as winter wheat and maize: this is already occurring in southern England.
A warming trend will encourage the planting of maize. In terms of the minimisation of runoff and erosion the choice is not straightforward. On deep, well-drained sandy soils suitable for maize, occasional summer thunderstorms give rise to serious problems (BOARDMAN *et al.* 1996). On the same erodible soils erosion occurs on winter wheat in every autumn but at generally lower rates. A change in climate to more summer thunderstorms and/or wetter autumns will alter the present day risk of erosion and off-site impacts on land under these crops. A modelling approach attempts to quantify the relative risk of wheat and maize under present and future climates.

Reference

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FALSE-COLOUR COMPOSITES DERIVED FROM DEM-VARIABLES AS A TOOL FOR GEOMORPHOLOGICAL MAPPING AND INTERPRETATION

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Visualising morphological features has been a major and sometimes highly problematic task in geomorphological mapping due to the related multi-dimensional information (slope, size, altitude, distance from other features, etc.).
The combination of digital elevation models (DEMs) and GIS software allows to create morphological variables which are calculated in an automatic and standartised way. Although these data can be stored and used in models digitally, analog maps on which the morphology is clearly visible are in a high demand as well.
The creation of colour composites of remotely sensed imagery is a frequently used and standard technique to reveal the three-dimensional information content. Combining morphological data in a colour composite (instead of reflectance values) enables to store and display a large amount of geomorphological information.
A variety of DEMs from different areas of Spain, Greece and Turkey were used to test the idea. Software has been developed to calculate variables from these DEMs such as slope length, relative relief, distance from and elevations above thalwegs, etc. to combine them in a morphological colour composite.
Since every DEM contains inaccuracies due to errors of measurement of altitudes, dislocation of the measurement points, methods of interpolation, resolution of the DEM, etc., errors also occur in the derived variables and are visualised in the morphological colour composites.
Apart from the inaccuracies of the DEM, methods of calculation of the variables are another source of errors. Tests on a DEM from an area near Zaragoza, Spain, showed that not all variables are equally affected by errors, and that the distribution of the errors is not random in space. Some of these variables being more liable to errors are less usable and this is the case with some areas, as it has been traced by using a Monte Carlo simulation.
Using a combination of slope, slope length, inverse slope length, altitude difference and inverse altitude difference to create morphological colour composites proved to be rather robust against all the errors in DEMs.
Examples from the cuesta relief of the Ebro valley (Spain) and a plateau area in Central Anatolia, (Turkey) were successful in the use of this technique and showed sheer similarities concerning data content with traditionally drawn morphological maps.

QUANTITATIVE CHARACTERISTICS OF THE GLACIAL RELIEF IN LITHUANIA

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When the Pleistocene inland ice retreated from the territory of Lithuania, various glacial, stadial and phasal formations were left behind which differ in their morphometric characteristics. Distinct differences can be observed concerning glacier margin formations where corner morainic tracts and connecting morainic arcs can be distinguished. Morphological differences are characterised by the following three parameters: height of landform, length and angle of slopes. Based on these parameters genetic and morphological differences of the marginal landforms can be specified.

The main morphometrical parameters of marginal glacial formations of various age are as follows:

Age	Location of formations	Height (m)	Slope length (m)	Slope angle (°)
Medininkai glacier (Q_{II})	morainic massives	20	320	3
	moraine chains	16	290	3
Nemunas glacier (Q_{III}) Grūda stage	morainic massives	13	160	6
	moraine chains	11	160	4
Žiogeliai stage	morainic massives	7	120	5
	moraine chains	11	200	4
Aukštaičiai stage East Lithuania phase	morainic massives	13	80	6
	moraine chains	13	110	7
South Lithuania phase	morainic massives	13	100	8
	moraine chains	10	110	6
Middle Lithuania phase	morainic massives	6	110	3
	moraine chains	12	280	2
North Lithuania phase	morainic massives	9	150	3
	moraine chains	6	290	1

THE SUBMERGED ZHUJIANG DELTA

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There is only one submerged delta on the shelf outside the estuary of Zhujiang River with an area of ca. 30,000 square km which is 3.5 times larger than the present-day estuary. It covers the shelf from the upper limit of the 40 m water depth isoline down to the marginal limit of the 120 m isobath.

The arc-like configuration of depth contours indicating an extremely wide shelf of about 270 km outside the present day estuary describe the outline of the submerged delta.

Geomorphological types are represented by relict landforms such as the five large systems of buried ancient valleys of 144-205 km length, a number of tidal grooves, and shallows composed of medium-coarse sand and submerged dunes. Based on their fan-like distribution they are apparently components of a delta geomorphology.

The relict sediments on the shelf having an inverted grain size distribution from land to sea *ie.* from silts to fine sands to coarse sands refer to the ancient origin of the submerged delta.

Using the data of seismic investigations, an isopach map of Quaternary deposition was compiled showing a general thickness of those sediments between 250 and 300 m and the isopach lines run in northeast and northwest directions being controlled by a structural line which is similar to that in the present-day Zhujiang delta.

From datings and studies on the sedimentation cycles and stratigraphic correlations it is considered that the submerged delta developed in four phases. At the end of the Q_1 stadial the upper limit of the delta was located near the present day water depth contour of 80 m and then the limit expanded southwest to the 100 m isobath by the end of the Q_2 stage and the three-beds structure formed at that time. Up to the Q_3 stage a transgression and the concomitant sedimentation disconnected the submerged delta from the modern one for the first time but the ancient shoreline presumably run along the -130 m contour during the maximum of the Late Glacial. Finally, the transgression during the postglacial period has produced a whole delta system including the submerged and the present day Zhujiang delta.

FLUVIAL PROCESSES AND THE DISPERSAL AND STORAGE OF METALS IN POLLUTED RIVERS (UPPER SILESIA, SOUTH POLAND)

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Localised in the highly industrialised area of Upper Silezia, the investigated rivers are polluted with waters discharged from lead and zinc mines. For the most part of these river courses the heavy metal concentrations are higher along the banks than in the active channel zone. This is caused by a slowed-down stream flow and increased accumulation of the polluted suspended matter in the offshore zone. The lowest concentrations usually have been found in channel bars. This is caused by a most intense reworking and mixing of the polluted sediments with uncontaminated alluvia eroded from river bed and banks. Slightly higher concentrations in the deepest, much more intensely eroded sections of the channel revealed accumulation of fine contaminated particles during low water stages.

The highest average concentrations of Zn, Cd and Pb occur along braided river reaches. Intense accumulation of suspended load over the floodplain, near the banks and in mid-channel bars cause relatively low differentiated concentrations of the investigated metals in transverse cross section of such reaches. In the downcutting (erosional) sections average concentrations are significantly lower. Sections of accumulation, as indicated by increased heavy metal content, are confined to the offshore zone and to small bars stabilised by water plants. Maximum differences between concentrations of metals in active channel and nearbank zone are observed in meander bends. They are proportionate to the amount of uncontaminated sediments supplied to the channel as a consequence of erosion of the outer bank.

Additional local effects of fluvial processes on the dispersal of metals are well observable. The effect of mechanical sorting is clearly visible on relatively short reaches of the surveyed channels: accumulation of the coarsest grains of sphalerite and galena in the active channel results in the highest concentrations of Zn, Cd and Pb whereas accumulation of the fine, predominantly dolomite and sphalerite particles in the nearbank zone cause lower concentrations of these metals.

Moreover, under "normal flow" conditions the amount of heavy metals carried as suspended load shows a relative increase downstream from the lead and zinc mine in comparison with the amount of heavy metals transported as bed load. It enables pollutant transport for tens or more kilometres from the source. High concentrations of metals in river sediments, persistent over long distances, are also promoted by downcutting of the river channel. This process constrains or makes impossible inundation and deposition of contaminated sediments over the floodplain. As a result fine sediments are not removed from the channel but transported and accumulated downstream. Accumulation of a significant amount of fine sediments in the channel is also promoted by artificially lowered river flow amplitude as a result of discharging the uniform amounts of mine wastewaters which do not cause scouring of fines downstream.

THE PRE-QUATERNARY MORPHOLOGY AND QUATERNARY EVOLUTION OF LAKE BALATON

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Data acquired by seismo-acoustic logging were used for defining the spatial distribution of lacustrine deposits as well as the morphology and structure of the Pre-Quaternary basement of the Lake Balaton. Given the diverse basement morphology, the thickness of Quaternary deposits in the lake varies in a wide range with an average value of 5 m. Over some elevations of the basement, the mud thickness is reduced to 1.0 to 1.5 m, whereas at depressions it increases to 8.0 m. A maximum thickness of 10 m has been detected in the mouth of the Zala River. The fracture zones of tectonically preformed meridional valleys and sites of initial "embryonic" sub-basins can also be observed. The average thickness of the mud is 6 m in the western sub-basins, 5 m in the central part and and 4 m in the eastern sub-basins of the lake. It is due to the size of the catchment area related to a unit water surface, and the quantity of deposits transported by watercourses into the lake.

On the basis of the pre-Quaternary morphology, the lake can be subdivided into 4 sub-basins (those of Keszthely, Szigliget, Szemes and Siófok) having different history of evolution during the Late Pleistocene and Early Holocene as revealed by paleontological studies of 8-10 m deep shallow boreholes. Results of paleontological investigations (palynological, diatoms, ostracods) allowed us not only to compile a more detailed stratigraphic classification but also to reconstruct the ecological history of the area. Although the Pannonian lake covered the studied area during the Upper Pannonian, it cannot be regarded as the predecessor of Lake Balaton.

Processes of erosion prevailed in the lake basin during most of the Pleistocene. The history of evolution of the present 4 sub-basins was specific in the Late Pleistocene. In most cases radioactive dating of peat allows us to date the beginning of inundation. A warm spell between 14,500-15,000 BP resulted in the formation of various small, shallow, clear and cool lakes. Inundation of the sub-basins took place progressively from west to east. The western part of the pre-Balaton was a marshy area surrounded by rich reeds and drying up frequently. It had a silty bottom and the related sub-basins had mesotrophic and meso-eutrophic waters. Depending on the climate, the lake surroundings were covered by pine and birch forests together with steppe-related plants during the Late Pleistocene.

In Holocene the warming up and abundant precipitation brought about a progressive rise in water level. The subsequent abrasion destroyed the ridges separating the small lakes. During this period the depth and trophic state of the lake changed frequently, and the water table fluctuated between altitudes of 104.6 m and 112.5 m, while the water quality varied between meso-eutrophic and eutrophic conditions. In the Holocene thermophilous mixed deciduous forests dominated. Agricultural and other human activities might have been going on at least since 2000 years BP.

GEOMORPHOLOGY AND KARSTIFICATION IN THE KESZTHELY MOUNTAINS, HUNGARY

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Keszthely Mountains are the SW fragment of the Transdanubian Mountains. Its main part is built up of Mesozoic carbonates, therefore the geomorphic and karstic evolution are in a close relationship. Hévíz Lake, the only warm water lake of Europe, SW of the mountains, and feds by the karstwaters of the Keszthely Mountains.

The first stage of the geomorphic evolution of the Keszthely Mountains was peneplanation under tropical climate following the Early and Middle Cretaceous orogenesis. As a result, the significant topographical differences between the two flanks of a reverse fault, the E and W part of the mountains have disappeared.

The oldest stage of karstification can be dated back to the Oligocene. On the peneplain of the Upper Triassic dolomites deep shaft caves and dolines were developed. They could be as deep as 100 m, based on a profile NE of the Keszthely Mountains. The infilling pelitic sediment underwent kaolinization under the warm and humid climate of the Early Miocene producing major kaolinite deposits that have been mined until the 1970's.

During the Badenian and the Sarmatian the Keszthely Mountains were an island of the Paratethys. The dissection of the peneplain started.

As a result of an intensive denudation the kaolinitic depressions have been eroded on the uplifted E part of the mountain. Because of differential erosion only the roots can be found in a thickness of a few metres on the central and W parts, while the paleoshafts are 20-50 m deep on the SW part.

Upper Pannonian lake sediments of various facies cover large areas of the mountain. The E part was a mainland where denudation continued, while the valleys of the middle and W part were mostly inundated (deposition of travertines and lignites). Karstification correlates well with the Pannonian shoreline. Karstic fissures (sometimes filled with breccias) are found 5-20 m beyond the former shoreline.

The Pannonian sedimentation followed the uplift of the mountain. A compression during the Quaternary resulted in an uneven uplift (more significant in the N part than in the S). An intensive incision of valleys, pedimentation and accumulation of huge fans on the marginal areas accompanied the uplifting. Caves in the valleys were developed during the ensuing Pleistocene karstification.

The age of the hydrothermal activity in the Keszthely Mountains is still debated. It is characterised by calcification on the NE and by silicification on the SW. Probably the oldest quarzite sediment of hydrothermal origin is 130 m beyond the Pannonian shoreline in an uplifted position. This hydrothermal alteration seems to be older than Pannonian. However, there are silicified Pannonian sandstone blocks in the NW. This is an evidence that the silicification continued even after the Pannonian.

MORPHOLOGICAL, HYDROLOGICAL AND ECOLOGICAL INVESTIGATIONS IN THE SOUTHERN GÖMÖR-TORNA KARST REGION

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The Gömör-Torna karst is located on the Hungarian-Slovakian border. The geomorphology of the Szilice plateau and the Alsó-hegy (Lower plateau) and the drainage of subterranean waters were studied in a long-term project in order to understand the nature of ecological risks.

The research was centred mainly on the southern part of the Szilice plateau, which adjoins and closely linked both morphologically and hydrogeologically to the Haragistya plateau and the Nagy Oldal in Hungary. The movement of the subsurface waters issuing from the Slovak karsts has not yet been satisfactorily detected, it is known, however, that they are filtering towards Hungary and appear in abundant karstic springs there (Kis-Tohonya, Lófej, Nagy-Tohonya springs, the springs of Ménes valley and the Kecső spring, whose water reaches Hungary partly on the surface and partly underground). As the water originating from the southern part of the Szilice-plateau and part of the Alsó-hegy is flowing towards Hungary all economic activities and interventions have direct impacts on the Hungarian part of the karst region, including protected landscape of the Aggtelek National Park.

With knowledge on morphological-hydrogeological links, the threat presented by the various pipelines was examined, mainly that of the so-called Friendship Oil Pipeline cutting across the Szilice plateau. After crossing the Torna-valley and continuing through Szilice, Borzova and Ardó, the pipeline finally reaches the Sajó valley. The findings of the investigation confirmed that a possible leak in the pipeline would have serious ecological effect in the heart of the karst region endangering primarily the territories of the Slovak Natural Conservation Area but would also affect the Hungarian side. The pipeline runs only about 1-5 km north from the border and, knowing the infiltration conditions, the oil would also appear in springs in Hungary. Environmental impacts of the cement factory and quarry at Torna situated on the eastern end of the Alsó-hegy on the Slovak side were also studied, and a conclusion was drawn that the damage through dust emissions and sound effects (explosions) on the natural life of the Aggtelek National Park is considerable.

The paper is meant to provide a rough outline of the results and some proposals listed below:

1) It would be important to eliminate the pipeline section across the Szilice plateau. Without too high costs a new route can be delineated through the Szoroskő pass or through a tunnel system built under the plateau.

2. The operation of the quarry at Torna should be limited. It should be examined whether international law allows a country to conduct an economic activity endangering nature through noise and dust pollution close to the border of another country. In the framework of privatisation quantity restrictions should be established so that the Alsó-hegy does not fall victim to any personal or lobby interests.

STUDIES OF LOESS IN THE AREA BETWEEN THE MECSEK MOUNTAINS AND VILLÁNY HILLS (SOUTHERN TRANSDANUBIA, HUNGARY)

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Loess deposits in Hungary are well studied. In the southern part of Transdanubia, there are still some profiles not yet described. They are located partly in the northern and southern forelands of the Villány Hills and in the Mecsek and partly in the hill region in between. The detailed laboratory analyses will hopefully provide new information on Pleistocene geomorphic evolution and on the nature of paleosols formed on ancient surfaces of various rocks.

The investigations began recently and the collected data point to great extremes of humus contents of grayish black chernozem-like soils in the southern foreland of the Villány Hills.

The horizontal distribution of paleosols found in the loess exposures of the northern foreland indicate that the erosional-derasional valleys of north to south alignment developed as early as the second half of the Pleistocene.

The reddish tint in the paleosols of the loess sequence overlying the lapiés surfaces of the limestone mass of the Mecsek Mountains seems to show that also the weathering products of limestone were involved in soil formation.

In the intermountain area well-developed and deep paleosols of medium brown colour are characteristic. The underlying loess of horizontal microstratification proves the reworked nature of the paleosol horizons.

HUMAN-INDUCED ENVIRONMENTAL CHANGES IN CENTRAL EUROPE

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The environment of Central Europe has overcome a dramatic change over the past 7000 years. Nowadays human activities are the decisive factors responsible for the geomorphic processes changing the relief component of the environment. A typical feature is the acceleration of natural geomorphic evolution (eg. weathering, soil erosion, karst processes, etc.) through deforestation, farming, industrialisation, urbanisation and the related air and water pollution (acid rains, chemical changes in surface and subsurface waters). New geomorphic processes and environments have developed (eg. cities as anthropogenic deserts). Recently the relief has been changed dramatically by technogenic processes and with the appearance of man-made landforms as highly frequent phenomena in Central Europe.

DEVELOPMENT OF PERIGLACIAL FEATURES IN THE SOUTHERN BÜKK MOUNTAINS (NORTH HUNGARY)

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Under the Pleistocene periglacial climate intensive geomorphic processes were active in the area of present-day Hungary. In the Hungarian mountains, including the Southern Bükk, periglacial features were overwhelming.
Field observations and laboratory analyses (grain size composition, water saturation and frost chamber experiments) were performed to reveal the diversity of landforms. It was found that in the Southern Bükk a number of factors influenced the development of periglacial features. There is a close interrelationship between the individual factors, geological structure, rocks, slope type and exposure, early Pleistocene topography, climatic properties and percentage of vegetation cover.
Under identical climatic conditions there is a striking regional asymmetry in the periglacial features due to composing rocks of the Southern Bükk. The western part of the Southern Bükk is poor in landforms; gently sloping slate surfaces dissected by erosionally deepened dry valleys and terraces are typical. In contrast, on the limestones of the eastern part remarkable cryoplanation towers and retreating scarps rise above the sorted debris of screes, stone flows and stone streams. Because of its close jointing, the Gray Flint Limestone and the Répáshuta Limestone fell victim very early to frost-riving and other exogenic forces. The more compact and resistant limestone types (such as Berva Limestone) are much poorer in features. The volcanic rocks add to the diversity of the landscape on slate and limestone terrains equally.
The varieties due to geological structure are primarily observed over the eastern limestone surfaces. Here a number of development stages and genetic types of rock arches are identified, such as arches developed from anticline with broad debris fans, arches, cryoplanation towers and scarps of concordant and tilted limestone strata.
The periglacial landforms of the Southern Bükk were primarily controlled by climate, structure and lithological properties. Among the modifying factors topography, slope exposure and vegetation cover played decisive parts in producing local varieties of features.

SAND WEDGES IN THE CARPATHIAN BASIN

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The sand wedges are to be found in a gravel quarry near Mogyoród (15 km northeast of Budapest) in the northern part of the Gödöllő Hills (Juhállás, 285 m a.s.l.). The age of their development based on western and central European analogies can be put to the Late Weichselian Glacial (Würm), ca. 17-20 Ka BP. The development of sand wedges have taken place under specific conditions.

Contraction fissures are filled from the surface with allochtonous, mostly sand sediments. Infilling usually is carried out by wind action. Eolian activity during the development of sand-wedge polygons results in a desert pavement on the surface.

Sand wedges can only form in very dry conditions. A pure sand wedge (without ice) only develops when temperature remains below zero for the whole year or when no water is available due to the absence of summer rains or spring snowmelt.

Minimum mean annual air temperatures below -12 °C and annual precipitations less than 100 mm are required for the formation of pure sand wedges.

Comparing sand-wedge casts to ice-wedge casts and cryoturbations, requirements for the development of the latter two are minimum mean annual temperatures of 4.5 °C for loamy soils and 8 °C for sandy and gravelly soils.

The sand wedges near Mogyoród have a polygonal system (convergent wedges, regularity), consequently they are considered sand-wedge polygons.

From the above it may be conluded that there was a continuous permafrost in the Carpathian Basin during the Late Pleistocene. The climate probably was very dry and absolutely cold, favourable for the formation of desert pavement.

IRON PRECIPITATON WITHIN THE ALLUVIAL DEPOSITS OF THE LISWARTHA RIVER IN THE WIELUŃ UPLAND (SOUTH POLAND)

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Iron precipitations of different forms are frequently encountered in alluvial deposits. Their nature and distribution within the deposit allow to reconstruct environmental conditions during sedimentation and to identify diagenetic processes.

Numerous forms of iron precipitation were found in the alluvial deposits of the Liswartha River (Wieluń Upland). Among them the most common are pseudofibres, spots and various forms of concretions from tiny 'peppers' to porous bog ores which form lenses and layers of various thickness. The Fe_2O_3 content ranges between 1.0 and 1.5 per cent for non-concretion precipitations and increases up to 14 per cent for iron concretions (accompanied by organic carbon content up to 1.5 per cent). Deatiled analysis of the chemical composition of bog ores revealed the presence of Fe_2O_3 ranging between 4.5 and 11.5 per cent accompanied by SiO_2 (75 to 82 per cent, predominantly quartz grains), MnO (0.8 to 2.2 per cent) and Al_2O_3 (2.4 to 3.6 per cent).

An attempt was made to carry out paleoenvironmental reconstructions based on iron precipitations found in the alluvial deposits. In conditions of vertical stability of the river channel and at a high level of ground waters a great amount of reduced iron precipitated as a result of excessive moistening of the floodplain sediments with an abundance of organic substances. Iron migrated to the oxidation sites and precipitated there as iron hydroxide. The presence of iron hydroxide with an uneven distribution of organic matter and the varied degree of oxidation resulted in a marble character of deposits.

In the depressions of the alluvial plain with vegetation growth and filled with water a high amount of reduced iron precipitated after the groundwater table had dropped. This was the start of bog ore formation.

ENVIRONMENTAL HAZARDS IN SOUTHERN TRANSDANUBIA

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Human factors are increasingly influential in geomorphic processes. Formerly, the southern Transdanubian region was heavily affected by mining activities, which caused considerable damage. Today waste disposal is regarded a major environmental risk also influencing surface topography not only in eastern Central Europe but it tends to be a global hazard.

Waste disposal demands extensive tracts of fertile land. The improperly treated or not sufficiently eliminated waste contaminates various elements of the environment, soils, ground water, surface water courses and air. The impacts are destructive to the landscape, both hygienically and aesthetically.

Communal waste is a source of deep conflicts in the municipalities, since their elimination is expensive and remains to be an unsolved problem. In the four countries of Southern Transdanubia annually 2.2 million cubic metres of communal solid waste accumulates. There are only a couple of settlements in favourable position, such as the resorts along the southern shore of Lake Balaton, which are capable of tackling the problems raised by the collecting, disposal and elimination of communal waste. However, not even their facilities meet strict hygienic/environmental protection requirements. In smaller settlements there is no hope to fulfill the tasks of appropriate waste treatment in the near future. This consequence of poor infrastructure is one of the major hazards in the physical environment. The situation is further aggravated by the fact that prior to 1982 non-regulated waste disposal sites were also used for the storage of hazardous wastes (industrial by-products, stained with oil etc.). Most of them can turn into a 'time-bomb' in the next century.

The most evident sources of conflict are the sites of temporary disposal or treatment of hazardous wastes. An example is presented from Southern Transdanubia. About 25 years ago a regional temporary disposal site for hazardous waste was established at Garé. By the early 1990's this site became a real source of danger, threatening the health of the population. In this locality the Budapest Chemical Works stores ca. 15,500 tonnes of chlorofluorocarbons (CFCs) in ca. 60,000 iron barrels. The CFCs derive from pesticide manufacturing. The iron barrels corrode with time and their hazardous fills percolate into the soils and disperses with ground water in all directions. It also contaminates the atmosphere to an untolerable extent.

The paper throws light to some of the regional environmental aspects of conflicts.

A GIS-BASED EROSION MODEL FOR TWO INVESTIGATION AREAS IN NORTHWEST SWITZERLAND

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A graphical soil erosion model has been developed for two investigation areas 20-30 km E and SE of Basel. The Upper Rhine valley site in the east has loess soils. The soils of the Swiss Jura plateau site (SE) are rich in clay. The model is process-oriented, showing the rain erosion risk for every field on the very spots where the relevant processes occur. For rainstorm simulaton the use of EROSION-2D as a dynamic model is proposed.

There are many soil erosion models and several of them can be integrated (partly or entirely) into a GIS (such as USLE, RVUSLE, EPIC, CREAMS, WEPP, ANSWERS, LISEM). However, applied to the clayey Swiss Jura plateau soils (>45 per cent clay content) such models have been found to overestimate soil loss. Moreover, parametrising catchments models has proved to involve an excessive amount of work.

Therefore a two-step procedure has been developed. First, endangered slope sectors within catchments of any size are identified. Second, real erosive rainstorm events at the relevant spots as well as corresponding countermeasures are simulated in a dynamic, event-related model (such as EROSION-2D and EROSION-3D.

The endangered landscape sectors are located with the help of SPANS-GIS. A rudimentary procedure is overlaying several information layers, namely relief (relief analysis is based on DEM 1:5000 and 1:25,000), soil (erodibility derived from the particle size range, stoniness and organic matter), land use (thickness of soil cover, crop cycles and tillage) and rainfall (erosivity). The different information layers are tied together with the so-called "index overlay" operation from SPANS-GIS. This procedure was used to give the particular parameters an appropriate significance to come as close as possible to the real conditions.

Relief analysis resulted in a map of gradients, a map of valleys and ridges, a map of concave and convex landforms and a map of the areas of deposition. These maps were transformed by overlay operations into two syntetic maps, a map of erosion dispositions in the areas of erosion and a map showing the erosion hazard quantitatively. These maps of synthesis have been examined and improved to the field conditions in the test field where a long-term monitoring is pursued.

The map "Areas of erosion and deposition" helps to locate the areas of the relevant proceses at a scale enabling detailed representation. The soil erosion risk map is the final product of the soil erosion model indicating the endangered spots of every field.

BIOSTRATIGRAPHIC AND GEOMORPHIC INVESTIGATIONS IN AREAS OF HUNGARY SUBSIDED DURING THE HOLOCENE

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As a consequence of crustal movements at the end of the Pleistocene and in the wake of the Holocene subsidence took place in several parts of Hungary. In the depressions formed this way a considerable amount of sediments have accumulated. These sediments contain a well preserved mollusc fauna.

Biostratigraphic investigations are significant contributions to Quaternary research in Hungary. The joint study of sediments in young depressions and of the fossil (mainly mollusc) faunas contained in them allow paleoecological conclusions. The author attempts to reconstruct geomorphic and biosuccessional evolution in Hungary during the Holocene.

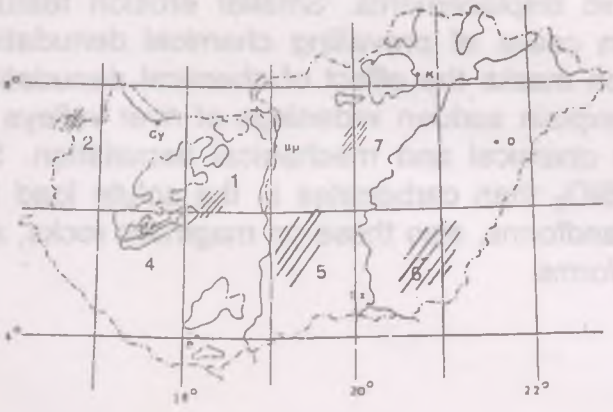
The best studied Holocene depressions of the country include the Sárrét (Fejér County), Lake Balaton, Lake Fertő, and the lakes of the Great Hungarian Plain (see the map).

Sedimentological and faunal investigations were carried out on 17 sampling sites and based on guide species three stages of the evolution were established from a deep lake with open surface to a peat bog:

1) Fluvial phase (Boreal): gravel, fine-grained sand, occasionally clay (Sárrét, Vörös-swamp in the Danube Plain);

2) Lacustrine period (Atlantic): lime mud as the typical sediment (Sárrét, Balatonederics, Danube-Tisza Interfluve). Higher plants appeared only in the second half of the phase;

3) Swamp and peat-bog formation (Subboreal, Subatlantic): formation of peat and mould of different thickness, depending on the local circumstances (Sárrét, Lake Fertő, Danube-Tisza Interfluve). Wet, periodically waterlogged areas.



Holocene lacustrine deposits in Hungary

I. Transdanubia: 1. Sárrét (Fejér county); 2. Lake Fertő (Fertőrákos, Fertőboz, Fertőujlak, Balf); 3. Lake Balaton (Balatonederics, Lesence: Lake Nádas); 4. Böhönye: Sáros-berek

II. Hungarian Great Plain: 5. Danube-Tisza Interfluve (Lake Petőfi, Lake Kolon, Lake Kerek, Vörös-swamp, Bócsa-Bugac area, Lake feketeszék, Lake Gasparszék, Lake Háromszögi); 6. Békes county (Lake Fehér, Körösladány; 7. Area of Jászság)

CHEMICAL DENUDATION AS A GEOMORPHIC PROCESS

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A still valid genetic classification of relief forms dates from the time when geomorphologists only registered the visible changes in nature. Thus, corrosion forms were observed in karst only. Numerous measurements of all constituents of river load call for the revision of this classification. Although the conclusions still seem to be disputable, survey already shows that on the global scale the ratio of the solid (mechanical) to solute (chemical) load is 6:1 or less. Besides, the salts are not counted among these chemical solutes, which originate from the sea and atmospheric precipitations (mostly HCO^-, Na^+ and Cl^-), while the suspension of soil particles and litter, containing partly dissolved minerals as well, is added to the solid load. The share of the latter had been greater before the forests were anthropogenically reduced in the Holocene, because biochemical corrosion had still contributed the major part to river transport then.

The necessity for revision of genetic classification was also indicated by more recent measurements of the river load on the southern rim of the Pannonian lowland performed in individual river basins, mainly composed of partially carbonate, impermeable Tertiary terrigenous sediments. No karst forms can be found in them. The rate of chemical denudation is lower there than in the neighbouring Dinaric Karst with equal specific runoff only during high water stages on rivers. If non-carbonate constituents of the solution are also taken into account, chemical denudationis of even minor importance.

The systematic mapping of the southeastern Pannonian rim carried out by Slovenian geomorphologists four decades ago has proven to be unsuccesful because only the erosion forms were registered. The traces of planation on the levelled tops of ridges did show neither the necessary lowering along the streams nor general gradation. Genetic terrain classification is more difficult in larger forms because of the lack of knowledge on tectonic displacements. Smaller erosion features are created by running water also in cases of prevailing chemical denudation. In other words: mechanical denudation masks the effect of chemical denudation. With this fact at hand, it is easier to explain sudden widenings of river valleys in the sediments of intense simultaneous chemical and mechanical denudation. Since on the global scale there is more SiO_2 than carbonates in the solute load transport, it is more adequate to classify landforms, also those on magmatic rocks, as polygenetic rather than purely erosional forms.

HISTORY OF HUMAN IMPACT ON THE GEOMORPHOLOGY OF THE SOUTH TISZA VALLEY (HUNGARY)

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The present paper is aimed at the geomorphological study of a special reach of the Tisza River: the one extending between the mouths of Körös and Maros rivers, and the surrounding countryside. An attempt was made to survey what kind of man induced transformations occurred along the Tisza River and how these and the essential natural changes shaped the landscape.

The contemporary maps and surveys (see the maps of the first, second and third Austro-Hungarian military survey; the Korabinszky map collection of 1805; the *Praeliminaere Flusskarte* map series) and the recently available Landsat, SPOT images and aerial photos offer a good basis to trace the changes the South Tisza channel has undergone through for the last centuries. Satellite images help reconstruct the former (to our days selfcut or regulated) meanders and the configuration of shallow belt series (e.g. in the vicinity of Deszk and Nagyfa) show the area of meandering some thousand years ago.

In the framework of river conservation starting in the middle of the 19th century 11 bends were cut off in Csongrád County, making the river 58 kilometres shorter.

The extensive floodplain was reduced to a narrow foreshore pressed between the artificial embankments of the river, putting an end to the formation of the natural levees and to the "fok" farming typical of them.

AIR CIRCULATION IN KARSTIC REGIONS TRACED BY NATURAL RADON

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Starting from 1978 regular radon observations have been carried out in 30 caves of Hungary. The radon content of the cave air originates from the radium content of bedrock. The radon concentration in the cave air is influenced mostly by the ventilation increased by the temperature difference between the outside and inside air. To describe this ventilation and its effect on the radon concentration, we propose a simple model. The ^{222}Rn is a very suitable natural tracer to study subsurface transport processes of geological and hydrological character. Caves play an important part in modern life as they are very sensitive indicators of the environmental impacts, while their specific climatic conditions represent a considerable curative power for the stressed population. The radon can be potentially an easily measurable indicator, a reliable source of information in both respects.

GEOMORPHOLOGICAL SURFACES OF THE TRANSYLVANIAN CENTRAL MOUNTAINS (APUŞENI MOUNTAINS, RUMANIA)

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This paper deals with the reassessment of the problem concerning the geomorphological surfaces of the Transylvanian Central Mountains, a topic that have occupied earth scientists for the last eighty years. The first geomorphological investigations were made by the French geographer Emmanuel de MARTONNE, who described three levels using their orographic position, i.e. the Fărcaş, Marişel and Deva levels. Accordingly, these levels were shaped in three periods: the first one during the Cretaceous, the second in the Eocene and the third during the Pliocene.
After the 1960's a substantial amount of publications appeared on the topic. Some geographers (e.g. COTEŢ) questioned the classical de MARTONNE's theory. On the basis of tectonic, paleogeographical and paleoclimatic evidence the Transylvanian Central Mountains have undergone several phases of development. During the Cretaceous period a huge peneplain was formed under tropical climatic conditions. In contrast to de MARTONNE's viewpoint there have not been suitable conditions for peneplanation since the Cretaceous. During the Paleogene intense tectonic movements started and the Cretaceous geomorphological level had been dismembered, dislocated and buried. Some parts of the former level were exhumed repeatedly, other parts fell under subaerial impact. At present there are three or in some places even more geomorphological surfaces (e.g. in the Vlegyásza Mountains five levels can be distinguished such as Horgashavas, Zerna-Muncsel, Havasrogoz, Tarányos and Sebesvár) representing integral parts of the former Cretaceous peneplain. There are surfaces situated in the same orographic position though having undergone through different phases of evolution while other surfaces being now in various orographic positions have had identical history of development.

GEOGRAPHICAL HAZARDS WITHIN MORPHOHYDROGRAPHIC BASINS

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From our viewpoint the analysis of hazard phenomena lie within the scope of the dynamics of geographical systems. Therefore, it is indispensable to know the critical intervals beyond which some processes trigger negative effects. Such an analysis is more efficient than damage estimation because it provides clues about how to prevent these effects on the population or to reduce them to a minimum. Therefore, vulnerability and threshold values of degradation are almost synonymous.

The mapping of geomorphic hazards within morphohydrographic basins consists of the following steps: delineation of catchment basins, analysis of morphodynamic potentialities, mapping of geomorphic processes, mapping of geomorphic hazards.

For demarkation of catchment basins the Horton-Strahler method was used, especially for those of lower order presenting a more evident disequilibrium.

Two basins were studied with different tectonic and current morphodynamic potentialities:

1) The basin of the Calva River (179 km^2, 7th order), a tributary of the Mureş River in the Transylvanian Plateau built of Mio-Pliocene sediments of remarkable uniformity, of cemented sands with marl and clay lenses, of monocline structure, asymmetric relief and very active erosion developed on the cuestas.

The basin shows a relative equilibrium (1.34) with disequilibria occurring mostly in the 4th and 3rd order categories.

The following classes of soil degradation and geomorphic hazards figure in the area: a) high degradation with serious hazard, b) medium degradation with moderate hazard, c) low degradation with slight hazard.

2) The Tulburea Basin (148 km^2, 4th order) in the foreland of the bend of the Romanian Carpathians, of a tributary of the Prahova River. The river reveals relatively simple geological structures, folds of sands, clays and marls.

A critical area emerges at the confluence of the Tulburea with its tributary Ponciu where the relative relief is significant (165 m) and there is a strong impact of the oil industry. As a whole the basin presents an area with moderate to high levels of hazards due to deforestation and active morphodynamics.

STRUCTURAL EVOLUTION OF THE PANNONIAN REGION IN THE LAST 500 MILLION YEARS

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Encircled by the mountain systems of the Alps, the Carpathians and the Dinarids, the Pannonian (Carpathian) Basin is a geological unit of unique and rather complicated geological evolution. The previous concept about the geological history have been substantially modified by the data accumulated from recent geophysical exploration and a multitude of deep boreholes as well as by the progress of geological mapping and the emergence of new theories of tectonic evolution. It became obvious that the basements of young basins are formed by blocks ('terrains') of extremely heterogeneous nature. In the Paleozoic and Mesozoic these blocks had been located at great distances from one another and large-scale tectonic movements shifted them into the same region only by the early Neogene.

All the remarkable properties of the present-day Pannonian Basin (attenuated crust, anomalous geothermal gradient, unusually high rate of subsidence) are dated to a later stage of evolution, to the Neogene. The mentioned tectonic processes are still active.

The geological evolution of the basin can be divided into the following stages:

1) Pre-Alpine stage - with the effects of Hercynian orogeny dominating;
2) Stage of development of Alpine geosynclines in the interval between Upper Permian and Lower Jurassic (stage of divergence);
3) Alpine orogenic stages in the interval between the Middle Jurassic and early Neogene (stage of convergence);
4) The development and evolution of the Pannonian Basin in the Neogene.

HOLOCENE FLOODPLAIN EVOLUTION ALONG THE UPPER AND MIDDLE COURSES OF SMALL RIVERS IN LOWER SAXONY, GERMANY

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Like other upland valleys of Central Europe, those in Lower Saxony are also characterised by pronounced valley floors of fine-grained flood plain sediments, the so-called *Auelehm* (meadow loam), deriving from the loess mantle of the surrounding slopes. At the base of these sediments there are gravels the upper layers of which have proven to be of Late Pleistocene origin, subsequently reworked during the Early Holocene. Along the deeply incised valleys of the main rivers as the upper Weser, Werra and Leine this floodplain is normally about some hundred metre broad and the *Auelehm* reaches a thickness of 4 to 6 m.

Floodplain sediments were dated by ^{14}C analysis, pollen analysis, artifacts and using the heavy metal content as an indicator for times of smelting activities. They show that the floodplain development along the middle courses of the main rivers started about 6000 BP, *ie.* in the Atlantic, and had been accelerated since Neolithic times and again since the European Middle Ages. Only in the Leine valley there is evidence of the beginning of the floodplain aggradation already in the Preboreal, and about 30 km southeast of the investigated area, within the subsided Eschwege basin, the fine-grained floodplain deposits date back to the Older Dryas phase.

In the upper courses of these valleys and of their tributaries there are also floodplains, but only about some ten metres wide and with fine-grained sediments less than 2 m thick. Datings testify to the beginning of sedimentation in the Middle Ages, along the uppermost reaches even only since the 17th century. So there was a delay in floodplain development along the upper courses of the rivers. For the middle courses of the tributaries of the Leine River this delay is also apparent, in comparison with the middle reaches of the main river.

Auelehm sedimentation induced by the Pleistocene/Holocene climatic change and accelerated sedimentation caused by human impact (mainly by deforestation), support the following conclusions: Caused by the change of discharge and by the availability of fine-grained material only, aggradation started in the lower and middle courses of the main valleys and rivers due to a lower gradient and the higher frequency of floods. The process moved upwards the rivers but did not influence the relatively steeper upper reaches. Starting with the Neolithic Age, the deforestation responsible for soil erosion and supporting sedimentation, also mainly affected the broad middle and lower courses of the valleys and only later the upper reaches. Floodplain development proceeded upriver. Holocene floodplain evolution along different reaches has not taken place in the same way everywhere but varied with the actual hydraulic situation.

RIFFLE STABILITY IN RELATION TO MEANDER FORMS AND PROCESSES

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Riffles are important morphological and sedimentological elements of many meandering rivers. In conventional meander models they are assumed to occur at the points of infelction. Models of evolving bends have shown that additional riffles may develop in the apex. Bar and bend theories of meander origins predict certain positions and behaviour of riffles. However, rarely has the stability of riffle position been monitored for any extended length of time in the field. In this paper the results of annual monitoring of ca. 100 riffles over a period of 15 years are presented.

The position and form of rifles in a 12 km length of meandering channel on the River Dane in northwest England have been measured by annual mapping and photography. The information from these annual surveys has been compiled in a database: data noted include location of the riffle, position in bend, number of riffles in bend, shape of the riffle, relation to bars and relation to bank erosion and sediment sources. Associations between the stability of riffle position and meander mobility are found. Some association of rifle form and riffle stability is also apparent. The relationship of riffles to bar morphology is complex.

The data allow analysis of the dynamics of riffle instability and the extent to which movement is consistent, variable or periodic. Evidence of spatial propagation of instability through bends is also examined. The particular cases of riffle instability in reaches of a) mid-channel bars and b) sections straightened by cutoffs are illustrated. In a few instances change in riffle form or position in bends can be related directly to sediment input from bank erosion.

TEPHRA STUDIES IN THE YOUNG LOESS SERIES OF HUNGARY

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In the Carpathian Basin there is a very important marker horizon in the Pleistocene loesses, called "Bag Tephra", which is 300 - 400 Ka old. Its origin is not yet clear, but it is very probable that volcanic ash was transported several hundred or some thousand kilometres from the site of a volcanic eruption. Therefore it is conceivable that there were some more large volcanic eruptions in the same area, and thus more tephra deposition in other places, *eg.* in the Carpathian Basin.

This presentation is aimed to show the new heavy mineralogical investigations into the younger loess series in Hungary. The systematic sampling allowed us to recognise the volcanic intercalation even if it is not visible in the field.

By the means of the new marker horizon we can establish precisely the loess stratigraphy in Hungary.

This investigation is sponsored by the Magyary Fellowship.

NEW GEOCHRONOLOGICAL RESULTS OF LUMINESCENCE DATING OF THE HUNGARIAN LOESSES

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For the last few years there have been significant changes in the loess stratigraphy of Hungary. According to the most accepted conception (PÉCSI 1992, 1995) the paleosol BD_2 was considered to represent the Last Interglacial.
Based on a combined luminescence dating, a new chronology is proposed for the "Young Loess" in Hungary. Luminescence dating, supported by the aminoacid chronostratigraphic results (OCHES and MCCOY 1995) suggests that the loess below MF_2 horizon formed during the penultimate glaciation. For MF_1 horizon and interstadial within oxygen-isotope stage 3 is most likely. For the youngest loess a very high accumulation rate was found. Amazingly, large time gaps occur above MF_2 and MF_1 indicating that most of the record of the Last Glacial is missing in the standard sections at Basaharc, Mende and Paks. Either large discontinuities or a very low accumulation rate have occurred in all three type localities.
High resolution studies of climatic proxies through combined luminescence dating provided a reliable chronological framework for loess and loess derivatives of the last glacial in Hungary, even though incomplete evidence does not allow a correct and complete chronostratigraphic reconstruction.

LAND COVER CHARACTERISTICS AND GEOMORPHOLOGICAL UNITS OF HUNGARY - A SPECIAL INVESTIGATION OF THE CORINE PROJECT

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The name of the project - CORINE - is an acronym meaning CO-ORDINATION OF INFORMATION ON THE ENVIRONMENT. Its major task is to establish a computerised inventory of land cover.

The project is worked out by the European Union as part of the PHARE Environmental Programme, to create a compatible digital data base of land cover classes at a scale of 1 : 100 000 by the application of remote sensing data.

The nomenclature of the CORINE project distinguishes 44 classes, which are grouped into a 3-level hierarchy. The main level categories are artificial surfaces; agricultural areas; forests and semi-natural areas; wetlands and water bodies.

The authors have investigated several Hungarian geomorphological units in mountains as well as in lowlands according to the land cover terminology at 1:100 000 scale through the application of LANDSAT-TM remote sensing data. The starting point of the research was to study how land cover reflects the effects of geomorphological processes and how does the configuration of the geomorphic units coincide with the land cover data.

Our studies had the following aims:

- to identify the land cover units in the investigated areas,
- to show how the types of land cover are distributed under different relief conditions.

By overlaying the land cover data base with the map of geomorphological units we could analyse the characteristics of certain areas. Through the comparison of land cover units of the border areas with the geomorphological units, both overlaps and shortcomings could be detected.

RELIEF TYPES OF COUNTY NÓGRÁD (NORTH HUNGARY)

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Landform classification and relief typology are important tasks in geomorphology. The concepts of 'classification' and 'typology' are often used as synonyms although they should be interpreted as subsequent stages in a two-tier process.

The first step, of analytical character, is *classification*, identification of categories by certain quantitive and/or qualitative criteria. In contrast, *typology* represents the integration of relief classes based on certain common criteria. *Relief types* are units in the given area, clearly delimited in space, which show the characteristic features of the groups theoretically formed by certain classification criteria. (Here 'type' do not only denote a theoretical concept, but also the spatial unit representing it). However, not all groupings can be regarded *typology*. The identification of types has to be founded by a detailed, well-considered and uniformly applied system of criteria, as comprehensive as possible.

Depending on the number of criteria observed, simple (single-criterion) or complex (multiple-criterion) relief types can be mentioned. The criteria include:

- *geological conditions*, structure, dominant rocks and their age;
- *morphogenesis*, influence of dominant geomorphological processes;
- *morphography*, morphometrical parameters.

Moreover *size of landforms* must also be considered and the *hierarchy* of the types should be worked out.

Applying the typology for Nógrád County the fundamental distinctions are between well-known, unambiguous morphographical categories (e.g. mountain, basin, plain) complemented by the mentioned other criteria. Since this small (2544 km^2) county of Hungary has varied lithology, geomorphology and topography, 9 main and 23 subordinate types could be defined. As regards the morphometrical parameters, the elevation and a so called dissection index (X) - created by the author - provided base for distinguishing between the subcategories. Since the dissection of the surface can be identified by multiply horizontal and vertical components, this index was defined as

$$X = 1{,}5 \cdot \sqrt[4]{Rf \cdot Vs} - 0{,}5$$

where Rf is relative relief (m/km^2) and Vs valley density (km/km^2).

For example Type 2 'Hilly lands, consisting particularly of Oligocene-Miocene sedimentary rocks, strongly dissected and transformed tectonically and erosionally by the Neogene and Quaternary' , dominant in Nógrád (54.42 % of total area) can be subdivided into four distinct subtypes (e.g. 2B 'Hill ridges with an altitude of higher level ($\geq$300 m), medium level dissected (X<6)' or 2C 'Hill ridges with an altitude of lower level (<300 m), strongly dissected (X$\geq$6)', etc.

These types are represented on a 1:100 000 map.

ORIGIN OF VALLEYS AT THE EASTERN MARGIN OF THE BOHEMIAN MASSIF AND THEIR NATURAL HAZARDS

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The tectonic origin of valley sections at the eastern margin of the Bohemian Massif was crucially affected by the formation of forebulge and normal faulting along zones of strong tectonic disturbance of rocks. The neotectonic elevation was called forth by an uplift as a part of a flexural bending occured after a continent - continent type of collision between the North European Platform and the system of Carpathian and Pannonian blocks on the Carpathian-Badenian period divide. This alpine morphostructure can be delimited using geomorphological observations. The tectonic valleys either open themselves into graben like sections of the Lower Badenian foredeep, into its salients, or link up to grabens of two submarine canyons in the basement of the foredeep.

As the main proof of the tectonic origin of mainly NW trending valleys, demonstrated on the example of the Jihlava river, can be considered the block morphostructure and geophysically (by the VLF-method and georadar sounding) proved existence of faults at the contacts of higher- and lower-placed blocks in grabens, the reverse dip-slip faults in Older Miocene sediments above the valley and the identification of sediments of submarine gravitation flows and debris avalanches directed towards newly formed valleys called forth by tectonic movements in Upper Miocene. The tectonic features of the valley are successively being finished in their forms from very origin by processes of gravitational spreading with manifold failure appearances as consequence of cracks and fissures opening by tensional stress and step-like normal faulting of blocks that follow planar or curved shear planes lying in stress fields of gravitation spreading zones. In the inclined surfaces of blocks which now form the valley sides and on their margins have also been found quite a number of gravitational failures in the form of downhill facing scarps, various types of tensional gashes, double-, triple- or multiple-crested ridges and slope benches. The valley development peculiarities have formed the conditions for natural hazard existence. Among the latter it is first of all gravitational spreading induced deap seated creep or slides and rockfalls, piping in gullies, and flash floods in catchments of a small half-grabens, that require increased attention. Areas affected by gravitational spreading display disturbed stability conditions.

ON THE LOWEST SEA LEVEL DURING THE CULMINATION OF THE LATE GLACIAL IN SOUTH CHINA

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There are different opinions about the lowest sea level during the culmination of the late glacial in South China. Using comprehensive analyses of relict shelf sands, submerged beach rocks, relict landforms, sedimentary cores of sea floor, coral reef and extension of continental area it is suggested that the minimum sea level at that time was ca. 80 m lower than the present day one.

The present situation of littoral sediments cannot be directly used for establishing the ancient sea level. For example, it is reported that some relict sand samples at an elevation of -103--125 m dated to 15,844-14,320 years BP have been found on the shelf outside the estuary of the Zhujiang River. However, taking into consideration the subsidence of the shelf caused by hydroisostasy and sedimentary load due to postglacial transgression, the original location of the samples could be at -72--37 m to be regarded as the approximate position of the ancient sea level. Similarly, the submerged ancient streams and dunes located now at -80--100 m may represent the sea level of -50--70 m.

The elevations of landforms as indicators of the lowest sea level are varied. For example, the beach rocks are found at -2--3 m and -42 m in Shenhuwan Bay and off Nanao Island respectively, the relict sands are at -33--41 m in Taiwan Strait and the littoral sediments are even 2-3 m a.s.l. in Putian, Shaoan and Dongshan. This situation is probably attributed to the differential uplift of fault blocks.

Unconformity Q_3^3 at an elevation of -93--129 m can be found in some sedimentary cores from the shelf outside the estuary of the Zhuijang River, but the revised elevation is -60--89 m. In some borehole sections of coral reef in South China Sea, unconformity Q_3^3 between the lower coral reef limestones and the upper gravels with shell fragments can also be seen with an actual elevation of -15--17 m, because the coral reefs have been uplifting. However, this higher-lying unconformity suggests that the sea level was not so low during the Late Glacial maximum. In addition, in the coastal region some phenomena related to the base level of erosion such as Q_3^3 - lowermost level of terrestrial sediments at -20--60 m, river beds at -42--67 m and bottom of karst caves at -40--80 m - also support the conclusion that the lowest sea level was at ca. -80 m.

PALEOENVIRONMENTAL CHANGES AND GEOCHEMISTRY OF LOESSES AND PALEOSOLS IN SOUTHEASTERN TRANSDANUBIA, HUNGARY

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Quaternary sediments reflect environmental changes, under the impact of which they have developed. Mineralogical composition and distribution of chemical elements in loesses and paleosols are determined by paleoenvironmental conditions. Consequently, changes in the mineralogical composition and geochemistry of sediments allow the reconstruction of the dynamic changes in paleoclimates and environments.

As climate becomes warmer and more humid, weathering and pedogenesis intensify. There is an enrichment of carbonate solutions, clay minerals, several main components and trace elements, and a more intense accumulation of Fe_2O_3, Al_2O_3.

Loess and paleosol samples collected from 15 exposures of "young loess" in southeastern Transdanubia were analysed as to their mineralogical and chemical composition.

On the basis of the geochemical data, the loess of the studied area can be divided into two distinct groups: weakly weathered loess and weathered loess. The latter have a lower carbonate (and CaO) and Sr content and a higher clay mineral and TiO_2, Al_2O_3, Fe_2O_3, K_2O, Li, Cr, Zn contents than the former. In the case of the weathered loesses the CaO/MgO and $(CaO+K_2O+Na_2O)/Al_2O_3$ ratios are lower and the K_2O/Na_2O ratio is higher. Weathered loess developed under somewhat more humid paleoclimatic conditions. Derasional loess of the area belong to weathered loess types.

Compared to the different types of loesses, humic loess horizons have higher TiO_2, Al_2O_3, K_2O, Na_2O, P_2O_3, Cr and Zn contents and lower CaO/MgO and $(CaO+K_2O+Na_2O)/Al_2O_3$ ratios. Quantities of CaO, MgO and Sr show a slight decrease due to a poor leaching of carbonates from these horizons representing an intermediate formation between loess and chernozem-like steppe soils. The intensity of weathering and of pedogenesis reaches their maximum in chernozem-like steppe soils. Carbonates have been leached out almost completely from these levels. This soil type has the highest SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, K_2O, Li, Cr, Zn and Pb and the lowest CaO, MgO and Sr contents. As the rate of weathering increases, CaO/MgO and $(CaO+K_2O+Na_2O)/Al_2O_3$ ratios for the paleosols decrease gradually and their values reach minimum in chernozem-like steppe soils. Also the highest K_2O/Na_2O ratio is typical of these soils.

SOIL EROSION MAPPING THROUGH GIS AND REMOTE SENSING

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The paper presents an application of GIS and remote sensing methods in a test area for the purposes of
a) drawing a soil erosion map,
b) relating morphometric properties to the degree of soil erosion,
c) the analysis of relationships between land use types and soil erosion,
d) the analysis of land use changes and their influence on soil erosion.
The study area is in the western part of Hungary, between Lake Balaton and the Austrian border. The results were also compared with those of a similar area in Austria, close to the border.
A GIS was bulit up from data levels of morphometric maps (derivatives of the digital elevation modell), soil and land-use maps. The soil erosion map of the area is based upon detailed field research, ie. on catenas sampled by soil profiles and auger holes in a small wastershed and on areal photographs of the broader environs. Windowing the same area on digital satellite images and producing different colour composites, various interpretations were applied. The land use maps of 1984 and 1991 were constructed from satellite images. Land use hardly changed during the last 20 years and thus it cannot be a driving force of changes in the rate of soil erosion.
The investigations proved that remote sensing methods are a useful tool in soil erosion research. For the extension of the soil map for the neighbouring area mainly areal photographs were used. Comparing ground soil data and the interpreted colour composites good results were obtained for medium and heavily eroded soils. The main factors for the recognition were the reflectional effects of the cultivated B horizons and the loess as parent material.

SLOPE EVOLUTION SYSTEMS IN THE CURVATURE SUBCARPATHIANS

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The Curvature Subcarpathians lie between the Trotus and Dîmbovița river valleys representing the most complex sector of the Subcarpathians. They developed in the Carpathian foreland depression during the Miocene and Pliocene.

The present-day evolution of the slopes is influenced by the following factors: geological structure, lithology, sloping, drainage network and human pressure. This sector is characterised by a high density of population and settlements as a reflection of the economic potential.

Slope evolution can be grouped into the following systems according to the bedrock variations:

- system of the predominantly Pliocene sand formations,
- system of the mainly Miocene argillaceous-limestone formations,
- system of the primarily Paleogene limestone-sandstone formations.

The detailed mapping of the site and the detailed analysis of the maps have proven that the diversity of slope evolution is reflected by the morphodynamic potential of the area and by land use variations.

EROSION OF FIELD TERRACES IN MOUNTAINS

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Ancient developed systems of terraced farming are widespread over settled mountainous regions in different parts of the world. The present trend is to abandon many terraced areas, a process that increases erosion and sediment yield. When the supporting walls collapse terraces become strongly liable to erosion. The presented research addresses the problem of determining soil erosion rates in ancient agricultural areas quantitatively and of analysing the factors that control these processes.

The study program is based on field experiments in two countries. The first is in the Central Andes of Peru, at altitudes of 2800 and 3700 m in terraced areas on steep slopes with different land uses on active and abandoned terraces. The second is on the hills of western Galilee in Israel, on abandoned terraces overgrazed by cattle. In both sites small plots of 40 to 100 square m were installed to collect runoff water and sediment measured after each storm. Simulation of rainstorms by sprinklers was performed on terraces with different physiographic characteristics such as lithology, soil, exposure, slope, altitude, degree of abandonment, vegetation cover, in order to develop an empirical model relating environmental parameters to erosion.

During the 1995 season sediment yield for single storm events reached values of 0.5 to 10 g per square m in the Galilee plots and 0.5 to 1.0 g per square m in the Andes plots. These are relatively low values because most of the erosion occurs during the first years following their abandonment. Increasing erosion, heavy rains determine the failure of terrace walls.

Soil loss is an irreversible process. Therefore all developing and management projects should include soil erosion assessment for estimating erosion rates.

GEOMORPHIC EVOLUTION OF THE TRANSDANUBIAN MOUNTAINS, HUNGARY

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This paper presents the geomorphic evolution of the Transdanubian Mountains from the Cretaceous to the Quaternary. The method used is based on the study of sediments and subsisting morphological features reflecting paleoclimatic changes and orogenesis.

During the period concerned several sedimentary cycles occurred in the Transdanubian Mountains which were largely controlled by alternating uplift and denudation. The study of denudation allowed to distinguish valley development and formation of different planation levels. The surfaces formed this way had been frequently covered by products of successive deposition, later (partially) exhumed and transformed by renewed sedimentation.

During most part of the Early Cretaceous the mountains were buried under a sediment cover. The prevailing process of denudation during the Barrenian and Aptian stages was represented by fluvial erosion. As a result of tropical planation proceeding for 6-7 million years in the Albian stage, an etchplain formed in the area of the mountains by the end of the Early Cretaceous.

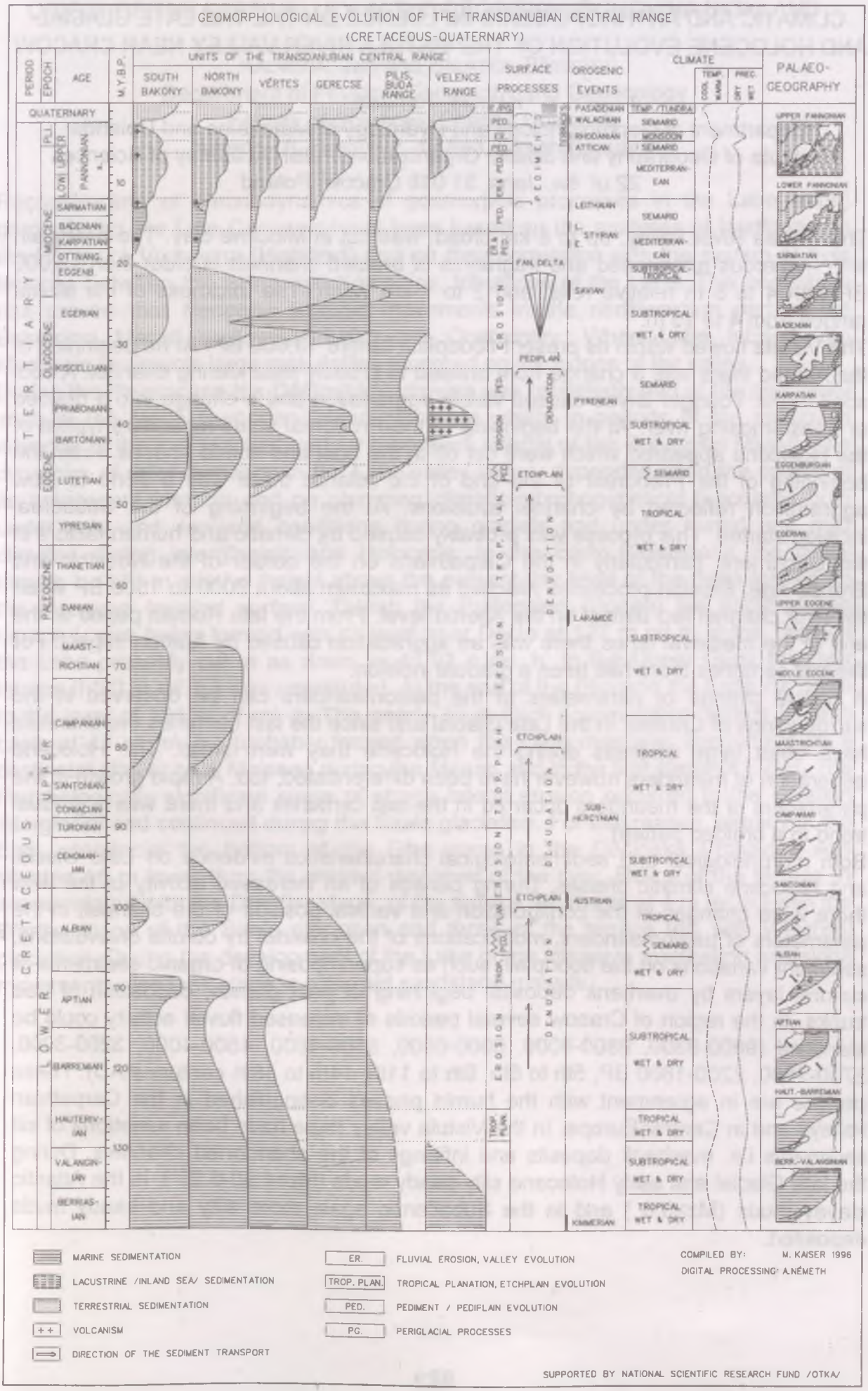
In the beginning of the Upper Cretaceous denudation prevailed for 10-13 million years starting with fluvial erosion giving place to tropical planation in the second half of the concerned period. A large etchplain was formed until the Santonian stage covered by the products of the following Upper Cretaceous sedimentation.

The same regime of denudation acted in Paleocene and Lower Eocene for 14-15 million starting with fluvial erosion followed by tropical planation resulting in the formation of another etchplain.

Succeeding sedimentation in the Middle and Upper Eocene valley development and pediplanation were the principal processes shaping the land for 6-7 million years at the end of the Upper Eocene and in the Lower Oligocene. During the Upper Oligocene and Lower Miocene the main part of the Transdanubian Mountains was covered by a huge alluvial fan and delta.

The formation of extensive planation surfaces ceased by the Neogene. Apart from valley development, pedimentation promoted by semiarid climate proceeded in the Badenian and Sarmatian stages, at the end of the Lower Pannonian and Upper Pliocene.

Starting with the Quaternary pedimentation, later fluvial erosion, periglacial processes and deflation were the principal geomorphic agents.


GEOMORPHOLOGICAL EVOLUTION OF THE TRANSDANUBIAN CENTRAL RANGE
(CRETACEOUS-QUATERNARY)
PERIOD
EPOCH
AGE
M.Y.B.P.
UNITS OF THE TRANSDANUBIAN CENTRAL RANGE
SOUTH BAKONY
NORTH BAKONY
VÉRTES
GERECSE
PILIS, BUDA RANGE
VELENCE RANGE
SURFACE PROCESSES
OROGENIC EVENTS
CLIMATE
COOL WARM
DRY WET
PALAEO-GEOGRAPHY
QUATERNARY
TERTIARY
CRETACEOUS
UPPER
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PLI.
MIOCENE
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EOCENE
PALEOCENE
LOW. UPPER PANNONIAN a. l.
SARMATIAN
BADENIAN
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LUTETIAN
YPRESIAN
THANETIAN
DANIAN
MAAST-RICHTIAN
CAMPANIAN
SANTONIAN
CONIACIAN
TURONIAN
CENOMAN-IAN
ALBIAN
APTIAN
BARRÉMIAN
HAUTERIV-IAN
VALANGIN-IAN
BERRIAS-IAN
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PED.
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ER. & PED.
FAN DELTA
PEDIPLAIN
DENUDATION
EROSION
ETCHPLAIN
TROP. PLAN.
PASADENIAN
WALACHIAN
RHODANIAN
ATTICIAN
LEITHAIAN
L. STYRIAN
E.
SAVIAN
PYRENEAN
LARAMIDE
SUB-HERCYNIAN
AUSTRIAN
KIMMERIAN
TEMP. / TUNDRA
SEMARID
MONSOON
MEDITERRAN-EAN
SUBTROPICAL-TROPICAL
SUBTROPICAL
WET & DRY
TROPICAL
UPPER PANNONIAN
LOWER PANNONIAN
SARMATIAN
BADENIAN
KARPATIAN
EGGENBURGIAN
EGERIAN
UPPER EOCENE
MIDDLE EOCENE
MAASTRICHTIAN
CAMPANIAN
SANTONIAN
ALBIAN
APTIAN
HAUT.-BARRÉMIAN
BERR.-VALANGINIAN
MARINE SEDIMENTATION
LACUSTRINE /INLAND SEA/ SEDIMENTATION
TERRESTRIAL SEDIMENTATION
VOLCANISM
DIRECTION OF THE SEDIMENT TRANSPORT
ER. FLUVIAL EROSION, VALLEY EVOLUTION
TROP. PLAN. TROPICAL PLANATION, ETCHPLAIN EVOLUTION
PED. PEDIMENT / PEDIFLAIN EVOLUTION
PG. PERIGLACIAL PROCESSES
COMPILED BY: M. KAISER 1996
DIGITAL PROCESSING: A.NÉMETH
SUPPORTED BY NATIONAL SCIENTIFIC RESEARCH FUND /OTKA/

CLIMATIC AND ANTHROPOGENIC INFLUENCE ON THE THE LATE GLACIAL AND HOLOCENE EVOLUTION OF THE VISTULA RIVER VALLEY NEAR CRACOW

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The Vistula River valley, up to 8 km broad, was cut in Miocene clay. The floodplain with numerous abandoned and fragments of braided channels is older than 13,000 BP with 4 to 5 m relative relief and 2 to 7 km width. The thickness of the alluvia ranges from 4 to 15 m.

The Vistula flowed within its present floodplain before 13,000 BP. At he beginning of the Alleröd there was a change from braided to broadly meandering channel. A cool spell of the Younger Dryas caused visible aggradation and a change into a braided or anastomosing river. At the beginning of the Preboreal small meanders typical of the Holocene appeared which were cut off in the cool and humid phases. From the beginning of the Preboreal till the end of the Atlantic there was a trend to slow aggradation reflected by channel avulsions. At the beginning of the Subboreal incision started. This process was probably caused by climatic and human factors in the catchment, particularly in the Carpathians on the border of the Neolithic and Bronze Age. Erosion processes reached its maximum about 2000 to 1500 BP when the river channel lied almost on the Alleröd level. From the late Roman period till the end of the medieval times there was an aggradation caused by human impact. For the last centuries there has been a gradual incision.

A typical change of parameters of the paleomeanders can be observed in the surroundings of Cracow: in the Late Glacial and since the last centuries the channels have been large whereas during the Holocene they were small. The Holocene generation of meanders however have been differentiated, too. A rapid growth of the parameters of the meanders occurred in the last centuries and there was a gradual trend to a braided pattern.

Both morphological and sedimentological characteristics evidence on Late Glacial and Holocene climatic phases. During periods of an increased activity of the river there were changes in the configuration and vertical position of the channel, in the parameters of paleomeanders, modifications of the channel by cutoffs or avulsions, sediment variations on the floodplain such as superimposing of organic sediments or cultural layers by overbank deposits, beginning of peat growth, deposition of tree trunks. In the region of Cracow several periods of increased fluvial activity could be identified (9800-9300, 8800-8000, 6600-6000, 5500-4800, 4500-4000, 3200-3000, 2700-2600, 2200-1800 BP, 5th to 6th, 9th to 11th, 14th to 18th centuries AD). These periods are in agreement with the humid phases distinguished in the Carpathian valleys and in Central Europe. In the Vistula valley there have been variations of silt sediments i.e. overbank deposits and infillings of the abandoned channels. During the late Glacial and early Holocene silty-sandy muds (Mz=4.50-6.25), in the Atlantic clayey muds (Mz>8.5) and in the Subatlantic again more silty and sandy muds deposited.

ORIGIN OF THE LABE VALLEY IN THE DĚČÍNSKA VRCHOVINA HIGHLAND

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Reconstruction of chronodynamics of geomorphic processes in the Labe (Elbe) gorge during the Late Cenozoic have been based on the analyses of landforms on the Děčínská Vrchovina (Highland) and on their correlation with the system of river terraces between the Bílina and Kamenica, tributaries of the Labe. This correlation has proven that Neogene tectonic movements in the northwestern part of the Bohemian Massif continued during the Quaternary. When Labe incised into Mesozoic sediments large rock defiles emerged on the slopes of the valley.
During the Pleistocene the Děčínská Vrchovina was repeatedly part of the periglacial zone of the North European inland glaciation which, in periods of the maximum advance of the ice, reached up to the northern margin of the Bohemian Massif. The dynamics of relief formation in the Labe valley largely depended upon the course of its antecedent incision and on changing climatic-morphogenetical processes both under cold and semiarid conditions during glacials and under humid and mild climates during interglacials and Holocene. In the Early Pleistocene the fluvial terrace I_1 (178 m relative height above the present-day level of the river) formed on the Neogene levelled surface. During the Prätegelen (Donau) the accumulation terrace I_2 was being formed with its level near Děčín at 127 m rel h. In the Tegelen the Labe probably cut in as down as to 92 n rel. h. In the Upper Günz the river terrace II (82 m rel. h.) was constituted. At the end of the Pliocene the Labe cut down to the level of 134 m of rel. h. The nearly 30 m thick accumulation terrace III (with basis at 43 m rel. h.) probably formed when the Labe river was impounded by a continetal glacier near Meissen during the Menap and in the first stage of Elster. The morphologically significant stage of strong lateral erosion occurred in the Holstein interglacial and continued during the Saale glaciation. For that reason, already in the Eem interglacial the bottom of the Elbe gorge in the Děčínská Vrchovina was situated 16 m lower than the present-day level of the river. Relics of the terrace VI are correlated with the Drenthe stage, of the terrace VII_1 (basis at 4 m rel. h.) with the Warthe stage of the Saale glaciation and those of the terrace VII_2 with Weichsel glaciation. During the development of the Labe gorge intensive weathering and slope movements also took place in exposed sandstone massifs.

LANDSCAPE ECOLOGICAL STUDIES IN THE MEDVES REGION, NORTH-HUNGARY

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In the study area, part of the Karancs-Medves Protect Landscape, the ecosystems have been largely transformed and the a cultural landscape was created. The extension of areas free of human impact have been drastically reduced.
The environmental consequences of natural and anthropogenic processes have been analysed and the ecosystems in natural or seminatural state have been mapped. It was studied how the survival of these ecosystems can be promoted.
The research methods applied included a GIS (MICROSTATION, IDRISI and ERDAS programmes) complemented with field checking. The information on the investigated area was digitised from topographic maps and satellite images were also used as a source of information.
Slope category and exposure was demonstgrated on a digital terrain model. The maps representing topography were integrated into the data base acquired from satellite images. The factors controlling the ecological functions of the landscape were mapped.

VOLCANOLOGICAL AND MORPHOLOGICAL FEATURES OF MIOCENE PYROCLASTIC FLOW DEPOSITS IN HUNGARY

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The Carpatho-Pannonian region was affected by large-scale volcanic activities in the Miocene. Two types of volcanism - silicic, probably extension-related and intermediate, subduction-related - occurred in response to the southward and westward subduction of a thinned crust of the stable Europe beneath the moving microplates of the region.

The extended silicic volcanism produced large amounts of ignimbrites and related fall and surge deposits (usually from unknown centres) but their majority were buried subsequently due to the subsiding Pannonian Basin. In Hungary there are few localities where their volcanological and erosional features can be studied: the Bükkalja (the southern foreland of the Bükk), in limited areas around the north Hungarian volcanic mountains (Börzsöny, Mátra and Tokaj Mountains) and in the Mecsek Mountains. The inferred original sheet morphology has been degraded by the subsidence of the basin and by the regional uplift of the above mentioned mountains. The most extended remnant surface can be traced in the Bükkalja, where despite faulting and rotation, at least two ignimbrite-forming eruption cycles and related plateau deposition can be inferred. In unique places, fossilised fairy chimneys have been preserved, and, probably as a recent phenomenon, badland formation can also be observed.

The subduction-related volcanism produced medium-size stratovolcanoes. Their initial activity may also have been resulted in ignimbrite formation (e.g. in the Börzsöny, Mátra and Tokaj Mountains): in some places, caldera morphology with pyroclastic flow and related fall-and-collapse breccia outcrops can be seen. The stratocones themselves are usually dome-dominated volcanoes characterised by lava flows and block- and ash-flow deposits. Selective erosion has produced remarkable "chimneys" and ridges, the latter preserving original radial flow direction.

THE ROLE OF MORPHOLOGY IN ENVIRONMENTAL POLLUTION

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The amount of pollutants emitted into the environment depends mainly on the character and intensity of producing and consuming activities. The spreading and concentration of pollutants in a given topographical place are greatly influenced by the natural factors. In the course of our work it was studied what role morphological features played in the contamination of subsurface waters by nitrates. The sample area was located near Cserépfalu in the Bogács basin on the foreland of the Bükk Mountains. A number of derasional, erosional and erosional-derasional valleys can be found here cut into the young pediment. The overwhelming part of the area isarable. The areal differences in the exposure to nitrate contamination are shown in a map. When it was plotted the greatest attention was paid, in addition to human sources of pollution, to the relief conditions. It was established that in the areas with serious relief hazard, subsurface waters are also highly contaminated. The analysis of samples from drillings showed that on slopes of different steepness the amounts of nitrates infiltrating with the soil solutions are varied and the depth of seepage differs also.

TECTONIC AND GEOMORPHIC EVOLUTION OF THE BÜKK MOUNTAINS, NORTH HUNGARY, WITH SPECIAL REGARD TO DOLINE FORMATION

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The present-day face of the Bükk Mountains began to develop in the Miocene, when the Tertiary surface of planation started to be dissected by valley formation and pedimentation. Karst processes on Triassic limestones intensified from the Pleistocene on. The previous buried karst was transformed into a mixed karst and the drainage of the buried karst inherited over the karst surface. The surface water-courses were replaced by underground drainage through the process of bathycapture (JAKUCS 1971). The presently characteristic dry valleys developed and they attracted row dolines.

The geological conditions of the Great and Little Plateaus are different. In the area of the Great Plateau, the Plateau Limestone of Ladinian to Carnian age overlying the Ladinian schist is easily affected by corrosion. A similarly important terrain for karstification is the limestone facies of the Little Plateau.

It is the Bükk Mountains where the thickness of Pleistocene deposits is the smallest in Hungary. The loam fill of dolines is shallower than 5 m. The loam soils and accumulations of weathering products play a significant part in the deepening of dolines. On the Great Plateau there are areas where as many as 32 dolines are found within one square kilometre, while on the Little Plateau an even higher value (39 dolines per km^2) was recorded. The paper presents areas where the density of dolines is highest and investigates the relationships between doline occurrence and geological/geomorphological conditions.

GRANITE LANDFORMS IN THE DYJE AND BRNO MASSIFS ON THE SOUTH-EASTERN MARGIN OF THE BOHEMIAN MASSIF

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The pre-Variscan Dyje and Brno Massifs were unmantled and deeply eroded already before the Devonian. The massifs were strongly affected by Variscan nappe tectonics, accompanied by cataclasis and mylonitisation. These processes were not favourable for the evolution of typical granite topography. On the extensive regional planation surface the only remarkable features are relics of a very thick kaoline weathering crust (80-100 m). Although tropical weathering was the primary process in formation of kaolines, the importance of Variscan nappe tectonics is undisputable. Granite landforms are more frequent in the Dyje Massif, probably owing to the deep level of denudation and less intense shattering. They occur on the southeastern marginal slope of the Bohemian Massif and in the deep river valleys, especially in the Dyje canyon. On the marginal slope, the most conspicuous forms are inselbergs. Some of them were buried under Miocene sediments and later partly exhumed. Tors and microforms (weathering pits, exfoliation) are rare. In the meandering Dyje canyon the granite forms are numerous and in general they are also younger. Most common are the valley-side granite tors and block fields. Microforms, *eg.* tafoni and pseudolapiés, mainly occur on the south-facing slopes.

CHANGES OF THE MORAVA RIVER BED, SOUTHERN MORAVIA

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The western part of the floodplain of the Morava river near Strážnice, Southern Moravia, Czech Republic, belongs to areas of geomorphological interest. The river forms here relatively large meanders in the meander belt, along the edge of a wide floodplain bordering on a wind-blown sand.

From the geomorphological viewpoint floodplains of large rivers in natural conditions on the territory of the Czech Republic belong to the most dynamically developing types of landforms strongly affected and reshaped by human activities, unique from both ecological and scientific viewpoints. Our research activity has focussed on this area since 1990.

To study the development dynamics of the Morava river bed, cartographic data from various time periods were involved and compared with the present-day state. Historical maps from the second military mapping (1836-40), and from the third military mapping (1876-77), and recent topographic maps (1960) were employed. The contemporary situation was surveyed combining operative aerial photography with visual interpretation of a SPOT false colour composite. The image interpretation has been supported by a detailed geomorphological fieldchecking.

Our investigations have proved that during the past one hundred years in the research area no major change occurred in the configuration of meanders. In the second half of the 20th century the cut-off meanders were originated within the meander belt, their development was extremely accelerated. During this time period (especially for the last thirty years) undercut slopes have shifted ca. 100-120 m, and slip-off slopes ca. 70-100 m downstream. The lateral erosion causes meanders shifting southwest, during this displacement (ca. 40-60 m for the last thirty years) meanders were closed off simultaneously.

The investigated area represents a highly dynamic element of relief and provides important data for forecasting the Morava River channel evolution. It is necessary to establish nature conservation on the study area and to undertake river canalisation.

COMPARISON OF LOESS TYPES IN HUNGARY USING GRANULOMETRY

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The granulometric analysis of loess varieties is aimed at specifying and extending the scope of the previously applied methods of evaluation.
The investigation covered the analysis and evaluation of key profiles in the loess-mantled areas of Hungary. A new granulometric method, not yet applied in Hungary, was used to determine fine-grained deposits, to distinguish them from each other and to draw more precise boundaries between the various regions.
In addition to its expected merits, the method allowed us to solve further stratigraphical, paleogeographical and geomorphological problems.
A completely new two sedimentological indices have been introduced in Hungary by the team of the Geographical Research Institute HAS. The basic relationship of fineness grade (FG) was recognised and explored by SCHMIDT, G.D. (1942) with the main formula elaborated by SCHÖNHALS, E. (1955) and first applied for eolian sediments of Lower Rhein-Westphalen (SIEBERTS, H. 1980). The degree of weathering (K_d) was employed by Chinese loess experts (LIU Tungsheng, AN Zhisheng). These two parameters completed the routine sedimentological indices (sorting Trask index /S_o/, kurtosis /K/, steepness /S_k/ and median value /M_d/) that have already been applied abroad and in Hungary (MOLNÁR, B. and KROLOPP, E. 1978, BÉRCZI, I. 1971). The above six indices can be used for environmental reconstructions.
Parameter values can be applied to distinguish between young and old loesses. The latter contain less $CaCO_3$, have a higher grade of fineness and positive K_d peaks of only medium values. They are better sorted with lower M_d, higher K and lower S_k values.
The results can be used in various fields:

1) as a supplement to paleontological methods in comparisons within and between horizons in a profile;
2) distinguishing between young and old loesses;
3) identifying source areas of loess from percentage values of FG;
4) correcting boundaries of deposits;
5) pointing out occasional hiatuses;
6) reconstructing warming and cooling sequences during loess accumulation;
7) identifying partial areas of deposition and erosion;
8) supplying information for engineers on the negative properties of loess (inclination to collapsing, suffosion);
9) correlation of strata for hydrocarbon exploration;
10) in education: for the comparison of loesses and loess-like sediments.

NATURE CONSERVATION ORIENTED EVALUATION OF GEOMORPHOLOGICAL FEATURES

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The primary task of nature conservation nowadays is the preservation of biological diversity, protection of the highly endangered botanical and zoological values. Although protection of the living nature should have a priority, the abiotic natural components are equally important constituting an equivalent part of the natural systems and representing unique, irreproducible values, therefore worthy of conservation.

The present paper deals with the conservation oriented evaluation of geomorphological features.

Geomorphological values represent a category already recognised by nature conservationists, but they are not yet properly explored scientifically. They are traditionally studied by geomorphologists and the results of fundamental research can also be used by nature conservation. On the other hand, there is a lack of special investigations aimed at evaluations for the purposes of nature conservation.

The first step of the special investigations is the identification of values. This means determination of rareness, uniqueness, typical character of the given object. As to the later, in addition to the appearance of the landform, an important aspect is its naturalevolution.

The second step of investigations is to define the stability of the featureand its state of endangerment. From among the anthropogenic risk factors it is most important to study the sensitivity to tourists' visits.

The aspects of identification of landform values and the opportunities of conservation are discussed on examples from the area of the Tokaj-Zemplén Mountains.

ALLUVIAL DEPOSITS IN UPPER SILESIA AS AN INDICATOR OF HUMAN PRESSURE DURING THE LAST MILLENNIUM IN SOUTH POLAND

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The southern part of Upper Silezia is drained by tributaries of the upper sections of the Odra and Wisła (Vistula) rivers. Evolution of the present valley floors started 13,000 to 10,000 years BP as the periglacial zone declined and the forests, after crossing the Moravian Gate invaded the studied area from the south. The southern part of Upper Silesia consists mostly of uplands (the foreland of the Carpathians) and plateaus (Glubczyce Plateau, Rubnik Plateau) covered by fertile soils which developed on loess and loess-like sediments. The area has been inhabited since ancient times.

There is evidence that in the early Bronze Age the area was partly deforested. This involved a massive soil erosion and in turn led to an increased rate of overbank sedimentation in the Silesian section of the Vistula valley. These deposits date back to ca. 3000 years BP. An extensive agricultural settlement of loess plateaus caused their nearly complete deforestation. As a result, considerable slope erosion and overbank deposition on the valley floor took place. Vertical sequences of these alluvial series are usually 1 to 1.5 m thick with organic remnants at the base dating to 900-1000 AD. On the top of these series a well-developed brown soil occurs. It suggests a stability of river channels and floodplains. Under forest soils the alluvial sediments are enriched with Zn upward the profile.

The balance of erosion and accumulation established by the end of medieval times along the valleys of Upper Silesia became again disturbed by the end of the 18th century due to industrial development, elimination of medieval dams and regulation of river channels, causing vertical erosion manifest in most of the valleys.

Extensive development of Zn and Pb mining started in the second half of the 20th century and led to the deposition of by-products in the river channels. In the vertical sequences of these insert terraces interbedding of coal dust occurs. In the valleys of rivers draining regions of Zn and Pb mining the concentration of these heavy metals is 10 to 100 times higher than in the older pre-industrial alluvial sediments.

GEOGRAPHY, REMOTE SENSING, MAPPING

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The 1980's saw a change of paradigm in mapping: high resolution digital images were already provided by resource satellites in the 1970's, which resulted in brand new thematic mapping methods. Although satellite remote sensing became a „quick" way of topographic mapping and updating (there are at least eight national or international satellite systems operating at present), several problems remain to be solved. The present dilemma of processing the traditional and remotely sensed data into maps lies in the resolution and repeatability of images.

Remote sensing is already widely applied in the following areas:

1) Meteorology and climatology particularly use data in weather forecasting and climatic studies. Only a part of the large data set is evaluated, temperature data are less reliable and precipitation is not measured. It is most useful in mapping the snow cover of extensive mountain areas.

2) Hydrology and hydrogeography use these data mainly in the study of runoff, observation of soil moisture, evaporation and rain or snow. Only high resolution and repeated satellite images can furnish terrain observation with additional information.

3) Agriculture. The image data have a major role in the study of the regional pattern of land use and classification of vegetation. The evaluation costs - without a link to GIS - are very high.

4) Forestry. Satellite data are used extensively for global vegetation mapping, regional forest classification and localising forest fires. „Local" forestry, however, prefers aerial photos (particularly with GIS data).

5) Land use (this type of information on topographic maps is often incomplete and outdated).

6) Research of non-renewable resources. Arid areas can be studied easily, but the rocks in other regions are usually covered. Geologists use visual and multispectral methods of investigation.

7. Oceanography (water quality, sea coast dynamics). Most useful when the image information is supported by water samples data. Aerial photography is efficient in discovering local problems.

8. Mapping. 30 per cent of resource satellite data directly serve cartography, which provide the map basis for GIS. The demand is highest for maps of 1:50,000 and 1:25,000 scales, which at present cover the land in 66 per cent and 34 per cent respectively. The standard method is aerial photogrammetry: its surveying limit conveniently supports mapping at 1:25,000 (positional reliability ±5 m, elevation reliability ±5 m, the threshold of object recognition 2 m) and also at 1:50,000 (±10 m, ±5 m and ±2-5 m).

THE IMPACT OF PONDS ON THE GEOCHEMICAL PROPERTIES OF ALLUVIAL DEPOSITS IN SOUTHERN UPPER SILESIA

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In the southwestern part of Upper Silesia favourable orographic, hydrological conditions and social-economic demand in the medieval times led to the construction of artificial ponds in the valley floors. Initially these were used for fish breeding, later the impounded water drove mills, bellows of ironworks and sledge-hammers, all having developed by and operated under the supervision of Cistercians. At the end of the 18th century there were about 260 ponds in the drainage basin of the Ruda River which occupied ca. 2000 hectares. With an average depth of one metre they are supposed to have held ca. 20 million cubic m of water. Industrial development starting with the early 19th century resulted in the decay of the ponds of which only a few have survived up to now.

Well preserved dams and flat sections of the valleys marking the extent of former ponds are distinct remnants of the medieval water reservoirs. Apart from the resulting transformation of the landscape the ponds also affected the granulometric and geochemical properties of alluvial deposits. It has been found that bottom sediments of the former ponds had a thickness of 20 to 40 centimetres. Consisting mainly of clay and silt with a high amount of organic substance they are superimposing sandy alluvial deposits poor in organic matter.

As far as the geochemical changes are concerned, studies on the concentration of selected trace elements (Zn, Cd and Pb) showed their marked differentiation along the vertical profiles of alluvial deposits in places where they became covered by lacustrine sediments. In the forested Ruda River basin with coal mining (since the end of the 18th century), heavy industry and urbanisation (developed in the mid-20th century), Zn, Cd and Pb concentrations in the pond deposits are ten times higher than in the underlying alluvial sediments. In smaller valleys draining agricultural areas this phenomenon is also observed but to a lesser extent.

The studies have shown that ponds had considerably changed the microtopography of the occupied portions of river valleys and transformed some geochemical properties of the alluvial deposits overlain by lacustrine sediments.

GEOLOGICAL MODELS OF PALEOKARST SYSTEMS: THEORY AND APPLICATIONS

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In the course of the last 15 years the new diagenetic school of paleokarst has been established after ESTEBAN and KLAPPA (1983). In contrast with the classical geographical and geomorphological approach the new concept of investigations, the sedimentological and diagenetic study of karst systems has been introduced. The most important considerations and conclusions are summarised in the following:

1) The evolution of the paleokarst systems is related to the cyclic development of carbonate platforms. Diagenetic paleokarst cycles are subsequent and phase retarded in time.

2) The formation and evolution of paleokarst systems is controlled by global eustatic sea level fluctuations, governed by global climatic changes.

3) The paleokarst horizons have formed in well defined sections of the carbonate platform, reflecting clear regularities in their distribution.

4) The main conduit zones are the cave horizons, parallel to the bedding, consequently they can be detected and delineated by simple geological and geophysical methods.

The introduction and application of this model has resulted in genetic reconstruction of long-term, multiphase karst evolution, demonstrated by some examples from Hungary and from different areas of the world.

The application of this concept and its practical implementation will be shown by the 3D models of composite karst systems of Hungary.

MIOCENE EVOLUTION OF THE PANNONIAN BASIN

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During the Miocene the Pannonian (Carpathian) Basin was a central part of the Paratethys inland sea, which stretched from the northern foreland of the Alps to Lake Aral in west to east direction.

The development of the basin is related to the collision of the European and African plates. As a consequence, the Alps and the Carpathians uplifted in the Miocene and, due to the arising extensional forces, in the area encircled by them a subsiding basin system formed. The rate of subsidence varied spatially and temporally. It reached its maximum in the Middle Miocene, when true deep-sea environments prevailed. In the Upper Miocene subsidence went on at a reduced rate and shifted towards the deep basins.

The changes in the biota of the inland sea and the characteristic endemic animal life, recurring in the various stages, clearly indicate the paleogeographical links and alterations in the sedimentation environments.

There are three tectonic stages in the evolution of the basin system:

1) In the Eggenburgian there still was easy communication with the world ocean. In the Ottnangian the contacts were broken up and characteristic endemic faunas developed. At that time, the Pannonian Basin was only linked with the western and eastern basins of the Parathetys.

2) In the Middle Miocene the rate of subsidence increased and broad sea arms opened towards the Tethys. This was the period when - within the Neogene - the richest biota populated the shallow and deep sea environments of sedimentation in the basin.

3) The Upper Miocene was a period of basin infilling. In the Sarmatian the area was completely isolated from the world ocean and formed an inland sea. In the Pannonian the inland sea was dissected into a lacustrine system with typical brackish, deltaic and fluviolacustrine seimentation environments.

On the Sarmatian/Pannonian boundary the basin was also separated from the Parathetys. An unambiguous paleogeographical link could be found with the eastern Parathetys in the Pontian.

The Pannonian-Pontian evolution of the basin is a history of desalinisation and infilling. On the Miocene/Pliocene boundary over most of the basin area was a fluvial plain and lacustrine and deltaic sedimentation was only limited to the deep depressions.

ENVIRONMENTAL CHANGES ON PLEISTOCENE/HOLOCENE BOUNDARY IN HIGH TATRA MOUNTAINS, POLAND

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The end of the Pleistocene and the beginning of the Holocene was marked by profound environmental changes in the Tatra Mountains. The Pleistocene/Holocene boundary is arbitrarily placed at 10,200 years BP, but the deterioration of the valley glaciers of the late glacial started much earlier. Although some researchers argue that the Tatra valleys were ice-free at the wake of the Holocene, there is evidence that small cirque glaciers existed until the Boreal phase.The main argument for defining the time of the full retreat of Late-Vistulian/Würm glaciers are lacustrine sediments of alpine lakes of the High Tatras. Decreasing severity of Pleistocene climate is reflected by the regression of the valley glaciers. Successive stages of this retreat from the maximal position are topographically marked by a system of eight terminal moraines. A ^{14}C dating of 12,500 years BP refers to lake sediment found at an altitude of 1620 m a.s.l. (Czarny Staw Gąsienicowy Lake) within moraine system of stage IV which is correlated with stage Gschnitz (Dryas I) in the Alps. Younger deposits of successive stages of ice retreat include moraines restricted to topographically suitable locations in hanging cirques up to 2000 m a.s.l. The highest moraine is correlated with massive minerogenic sedimentation of sands in the Czarny Staw Gąsienicowy Lake. It is suggested that these deposits had resulted from high-energy geomorphic events in the close vicinity of the lake when the glacier occupied its uppermost position and are dated to 8300 years BP. Therefore, this last glacial episode in the High Tatras is correlated with the Venediger phase in the Alps. Relict rock glaciers are common features at altitudes ranging from 1450 m to 1950 m. According to paleoclimatic reconstructions, boundary conditions for their development within the periglacial zone, *ie.* under discontinuous permafrost, existed in this altitudinal belt during the Younger Dryas (Dryas III). During Early Holocene warming periglacial realm shifted to an altitude of ca. 2200 m. This finding suggests that relict rock glaciers developed in the final stage of Tatra glaciation and probably were active until the Venediger phase.

BASALT SURFACES IN THE SLOVAK CARPATHIANS

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Basalts occur in three regions of the Slovak Carpathians: the Štiavnické vrchy (mountains), Cerová vrchovina (mountains) and the Lučenská kotlina (basin). The basalt volcanism was very diverse typologically. Most of the basalt reached the surface creating different types of landforms (stratovolcanoes, maars, lava flows, etc.). Intrusive basalts had been exhumed by the subsequent erosion and denudation.

Basalt volcanism had continued for ca. 7 million years from the Late Miocene until the Middle Pleistocene. The Pre-Quaternary volcanoes were destroyed by exogenic processes of relatively long duration developed under changing morphoclimatic conditions during the Pliocene and Quaternary periods. They are responsible for the profound postvolcanic destruction. Quaternary volcanic landforms were also affected by erosion. The intense tectonic movements of blocks and periglacial morphoclimatic conditions intensified and accentuated processes of differential erosion.

Volcanism of different type and duration and the intensity of postvolcanic erosion are reflected by the recent landforms evolved on basalt surfaces in the Slovak Carpathians.

The procedure of landform classification included the following steps:

- reconstruction of the initial volcanic relief,
- specification of the postvolcanic processes remodelling the initial volcanic landforms,
- evaluation of the degree of remodelling based on the relevant properties of recent basalt topography.

SOIL AND CLIMATIC CHANGE: PEDOLOGICAL AND GEOMORPHOLOGICAL STUDY OF A LAST INTERGLACIAL ALLUVIAL SOIL-SEDIMENTARY COMPLEX, WALLERTHEIM, GERMANY

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The Last Interglacial alluvial soil-sedimentary sequence of the Wallertheim site is well known for its Middle Paleolithic finds. The site is located at the contact between the alluvial plain and the neighbouring hill slopes, where Tertiary marl is outcropping. A ca. 35 meter high exposure has been carefully studied and sampled both in vertical and horizontal sections. The material consists of alternating clayey non-calcareous and silty calcareous sediments. The former are of alluvial origin, the latter correspond to colluvium eroded from the nearby upland slopes. The striking vertical and lateral variability recorded during the field and laboratory studies is attributed to the complex interaction of various processes acting along the margin of the alluvial plain.

Two important features are presented here in terms of their environmental significance:

1) Involuted layers described as cryoturbation pockets were interpreted in earlier studies as evidence of climatic change during the aggradation of the alluvial plain. Through careful study of the three-dimensional soil characteristics we concluded that the involutions are due to animal puddling and not to periglacial processes. This interpretation correlates well with the archeological data.

2) No evidence of periglacial processes could be observed during the aggradation of the alluvial plain. However, towards the end of the alluvial sedimentation there are clear traces of a short lasting very cold period, associated most probably with permafrost. Former soil characteristics, such as the structuration and porosity were wiped out by this very particular climatic impact. Arguments are presented that the melting of the permafrost has most probably been responsible for slump features and subsequent gully development having led to the local erosion of the alluvial soil-sedimentary sequence.

HUMAN IMPACT ON RIVERS IN HUNGARY AS REFLECTED IN CHANGES OF CHANNEL PLANFORM

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In the second half the 19th century, flood control measures radically changed the courses of rivers directly altering channel length, slope and planform. Out of the main types of channel planform (straight, meandering and braided) river conservation has set the least common one, the straight channel, as a target. (The measures affected the major rivers, which - in natural conditions - virtually do not have straight sections.) River mechanisms, however, began to counteract the consequences of confinement between dykes and to adjust river courses immediately.

Although river adjustment also involves other geometric parameters of the channel (width, depth, shape), an analysis of channel planform before human intervention, directly after it and today reveals how efficient the 'taming' of the major rivers of Hungary was in respect to the stability of the fluvial system. Investigating channel stability also has a bearing on some practical issues and, therefore, sediment transport (changes ensuing from reservoir constructions) and the passage time of floods also have to be tackled.

Until very recently in Hungarian hydrology and geomorphology a classification of river mechanism based on the German literature was applied. This paid attention to channel planform as well as aggradational or degradational processes. The identification of various types, however, varied with the authors.

In this paper sinuousity and a channel position index are used to describe river mechanism and to detect the changes caused by human intervention. Best suited for investigation are major lowland rivers with no direct tectonic control, relative homogeneity of bank material. Since more than a hundred years lapsed since human intervention, channel shifts up to 100 m are detected on topographic maps.

LAND CAPABILITY AND LANDSCAPE SENSITIVITY IN A SAND REGION OF HUNGARY

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Land capability refers to the range of potential uses of a given tract of land. It has to be viewed in close interrelationship with land(scape) sensitivity, ie. the predictable response to influences on the ecosystem, with special regard to surface conditions.
In the sand region on the Danube-Tisza Interfluve, central Hungary, the most intriguing aspect of environmental sensitivity is susceptibility to aridification. The steadily dropping groundwater table is the most striking consequence of decreasing precipitation amounts and growing temperatures. (The trend may be broken for the first time in two decades in the winter of 1995/96.)
The land evaluation GIS applied identifies classes of land capability on the basis of the evaluation of environmental factors for the cultivation of major arable crops. This computer map is superimposed on the map of environmentally sensitive areas (delimited by a set of criteria, the one with foremost significance being ground water table, while others signify potential wind erosion hazard). The resulting map shows areas where land capability is considerably reduced through aridification and a land use pattern more appropriate to the environmental potentials has to be found.
Another land sensitivity analysis is directed at the estimation of potential environmental loading from diffuse agricultural sources and from concentrated waste disposal.
In neither of these analyses can topography be regarded a negligible factor. The availability of water for crops directly (ie. controlling runoff rate) or indirectly (through soil types and various soil parameters) depends on the topographic location of fields. Intermittent flow in water-courses adds to the hazard of soil contamination.
The intricate interrelationships between land capability and sensitivity are illustrated by the beneficial effect of sand soils with multiple humous layers, which originally denote cycles of historical wind erosion, but at present favour the storage of water as soil moisture in soils with otherwise poor water retention capacity.

GEOMORPHIC PROCESSES MODIFIED BY URBAN DEVELOPMENT: THE CASE OF KOMLÓ, SOUTHERN TRANSDANUBIA (HUNGARY)

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Komló was declared a town in 1951. Previously, it was a small village, located in the valley of the Kaszárnya stream in the Mecsek Mountains. Urban economy and development was based on the mining of Lower Jurassic (Liass) black coal.
The town centre was built on Miocene (Upper Carpathian) sequence of sands, clays and clay marls, growing ever thicker to the northwest.
The most typical geomorphic processes of valley flanks of Miocene deposits are landslides. Before developments the typical landforms were landslide tongues, gullies and small alluvial fans on the flanks of the Kaszárnya valley. New housing areas were established in stages on interstream ridges of moderate landslide hazard (the estates called Kökönyös and Szilvás) and, to a lesser extent, on their slopes of strong landslide hazard (the estate Kenderföldek).
Urban development resulted in the following changes of geomorphic processes:
1) The valley floor of the the main valley, the Kaszárnya stream, was filled up and broadened in order to accommodate major establishments like a thermal power plant, a coal sorting plant and a sewage treatment plant. This involved the removal of the alluvial-fan material.
2) The subvertical walls of the erosion gullies separating housing estates were eliminated and artificially remodelled into 'erosional valleys' - at least in their shape.
3) The floors of tributary valleys were broadened and filled. Their drainage conditions deteriorated to a large extent.
4) The spoil heaps of slates accumulated during mining activities often lie on highly unstable slopes.
5) A number of man-made terraces were carved out of the slopes and the housing estates were built on them.
Subsidiary investments accompanying urban development reduced landslide hazard, but mass movements did not come to a halt. In many places of the town centre damage is made to buildings.
Sheet wash on slopes virtually stopped over almost 50 per cent of the built-up area, while there is an increase in the rate of infiltration.

GEOMORPHOLOGICAL ASPECTS OF REGIONAL PLANNING: EXAMPLE OF THE APUŞENI MOUNTAINS, ROMANIA

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Regional planning has recently been launched in Romania in a multidisciplinary approach. A Plan of Territorial Arrangement and Development is to be elaborated for the Apuşeni Mountains situated in the western part of the country.

Research and planning activities include geomorphological aspects which can be synthesised around two parametres:

- The actual geomorphological "offer" of the mountain region in concern including *quantitative* variables (referring to the morphometric potential), *genetic* types of relief and stages of evolution, *dynamic* processes and streams of substance and energy, and *territorial* aspects (surfaces, places and major areas). This "offer" is limited by the necessity to preserve natural values in the form of the National Park of the Apuşeni Mountains, for which geomorphological studies have had a specific character;
- The "demand" raised by the objectives of socio-economic development referring to such aspects as *accessibility* of the area (and types of hindrances), *geomorphological requirements* for various utilisations (land use, hydroenergy, settlements), *disfunctions* of geomorphological character (gravitational, and karstic phenomena, siltation of reservoirs, strong dissection of the terrain), geomorphic *risks* of different kind due to human impact.

Geomorphological studies are targeted at concrete solutions in the process of decision making when options and limits are to be duly taken into consideration.

PONTIAN PALEOGEOGRAPHICAL RECONSTRUCTION FROM BIOMETRICS OF MOLLUSCS (SOUTHEASTERN FORELAND OF BAKONY MOUNTAINS, HUNGARY)

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In the Upper Miocene the Mesozoic range of the Bakony Mountains rose above the Pannonian Lake as an archipelago. Along the shores of this enclosed lake a broad belt of river deltas were advancing into the lake. The shoreline and water depth was very changeable and the resulting environments for life also varied considerably spatially and temporally. The variation of fossil molluscs is a clear indicator of paleoenvironmental conditions.

In order to reconstructs the paleoenvironments of the Pontian stage (8.5 to 5.5 Ma BP), the gastropods occurring in great numbers in the Tihany Formation (*Melanopsis fuchsi* HANDM., *M. boueri sturi* FUCHS, *M. tihanyensis* WENZ and *Theodoxus radmanesti* [BRUS.]) have been studied. On the SE margin of the Bakony, between Balatonfűzfő and Csór, 2270 individuals of the four species were recovered from exposures and boreholes and analysed biometrically. Optical microscopic studies covered characteristic dimensions, shapes, pigmentation and sculptural ornamentation for the various species under different environmental conditions, while electron microscopy was applied to detect the ontogenetic evolution of the *Theodoxus* and small *Melanopses.*

From the occurrence, morphometry and the properties of the enclosing sediments, the following paleoenvironments can be reconstructed for the shore zone:

1) near-shore, deeper oligohaline water;
2) slightly oligohaline, lagoonal environment with wave action;
3-4) swamps produced by vertical movements of the neighbouring areas.

The diversity of molluscs from various environments clearly indicates the tolerances and environmental optima of the species. The optimal environment for the studied species was the oligohaline lagoon, where the illumination of water was favourable. With increasing water depth, the size and ornamentation of bottom-dwelling species feeding on aquatic plants reduced. In the shallow water their average dimensions grew and their ornamentation became rich and, at the same time, 'unstable'.

The method allows a paleogeographical reconstruction of the SE foreland of the Bakony and the regression of the Pannonian Lake in SW to NE direction can also be followed.

GEOMORPHOLOGICAL AND LANDSCAPE GEOGRAPHICAL INVESTIGATIONS ON THE SZENTENDRE ISLAND

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Research on the Danube valley has always been a major task of Hungarian geomorphologists. During the 1950's a view was developed by BULLA (1941), GÓCZÁN (1955), MAROSI (1955), PÉCSI (1959) considering the past 100,000 years a period of mainly river controlled surface development. The large number of publications outlining new results call for an overview of this concept and for the evaluation of recent hypotheses along with old theories. This paper summarises the new data emerging from the actual field research on the Szentendre Island.

The oldest island formations may have appeared during the late glacial Bölling. On their surface in the younger Dryas (or perhaps in the older Dryas) windblown sand formed but most specifically blowouts and residual ridges of moving fluvial sand developed. The geographical literature placed this kind of sand movement into the Boreal phase of the Holocene. Due to the incision and aggradation of the Danube, the island cores grew in size and new islands emerged in the following stages of the Holocene. The present-day Szentendre Island probably came into existence during the Subatlantic phase when smaller islands and island cores merged to form a single feature. In the 18th century new sand migration began due to human impact. The shorelines of the island were created in the 1960's when flood control and regulation work was finished. By the shores of the island even now shoals are being formed.

As part of the actual research a geomorphological map of the island was drawn, which clearly shows surface formations resulting from wind and water actions.

On the bases of the detailed geomorphological, pedological, botanical surveys and microclimatological observations, main landscape units (geotope groups) have been identified and proposals for land use are made.

THE PREDICTED WIND EROSION RATE IN THE CARPATHIAN BASIN

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The climatological estimates suggest 1 mm annual precipitation loss for the forthcoming 100-120 years and the same trend is thought to be realistic for the next decades. The predicted rise in temperature induced largely by artificial effects is ca. 0.1-0.2 °C per decade with a slight acceleration in its trend. This value corresponds to a 0.2-0.5 °C annual rise of mean global temperature.

On the basis of these two trends the average tamperature in the Danube-Tisza Interfluve may show a 0.5 °C rise in twenty years and 1.0 °C rise in fifty years. Calculating with the above precipitation change tendency, the annual rainfall will drop below 500 mm compared to the present 550-600 mm and that will not cover the water demand of the region.

The presented data sequences have direct and indirect ecological consequences. The most significant direct effect is the strong decrease of water supply coupled with social effects. They result in a growing aridification and in dropping of the groundwater table, which is to mobilise the sand movement in the region. Due to the changing climatic conditions 30-50 per cent increase of the wind erosion rate may be predicted.

The appearance of the Hungarian puszta landscape after 30-50 years will depend largely on the human impact. If the currently estimated physical processes continue to prevail in this region it might be expected that the natural vegetation will be succeeded by rather dry associations: weeds indicating a reduced diversity will become more common spread and also the juniper will do so at the expense of the oak-hornbeam groves. The comptetitiveness and acclimatisation of the species will change, too. The total ecological value of the vegetation cover will decrease. Some species will disappear even from the area of the national park. Agriculture has to be prepared for drier conditions than today. Especially the growing summer moisture deficit will result in a need for introducing drought-resistant species. The dropping winter electricity bill of the herdsmen watching the weed-grazing animals is but a cold comfort.

CHEMISTRY OF LAKES ON THE DANUBE-TISZA INTERFLUVE, HUNGARY

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The Danube-Tisza Interfluve can be subdivided into two morphologically distinct regions. The valley of the Danube is a five to twenty kilometre wide plain filled predominantly with fluvial sediments lying at ca. 90 m a.s.l. To the east windblown sands occur alternating with loess stretching from west to east 80 to 100 km with elevations 100 to 130 m a.s.l.

Earlier there were ca. 100 to 150 lakes in this area. The droughts of the last decade resulted in a drop of the ground water level causing the disappearance of these lakes. Their former locations are marked by carbonate deposits.

The lakes are part of the Kiskunság National Park, their role in the preservation of the aquatic biotopes has been essential. The need of an artificial recharge has emerged. The question is if the water to be used for this purpose was of adequate quality.

Geochemical, stable isotope, X-ray and thermal analysis of the lacustrine carbonates have confirmed that Danube valley lakes were recharged mainly from annual floods of the river, thus the lakes may be supplied from the Danube without a major risk.

Lakes in the higher divide area covered with eolian sands were recharged from precipitation and from groundwaters, thus the influx of local waters into these lakes would alter lakewater chemistry much less than a recharge from the Danube.

REGIONAL FEATURES OF GLOBAL CLIMATIC CHANGE ON THE LANDSCAPES OF HUNGARY

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There has been an increasing concern about global climatic change that may effect various processes in ecology and economy. This challenge may influence the landscape system and its functioning as well. As a response to this problem, a new approach to landscape assessment is based on the assumption that the likely responses to the change of such fundamental factors as temperature and precipitation can be evaluated by comparison of regions with different long-term climatic conditions.

The likely effects of global warming (in terms of increasing hemispherical mean temperatures and of fluctuating continent/ocean temperature differences) were calculated by MIKA (1991). This scenario was applied to the 230 microregions of Hungary. Changes in the temperature of the summer and winter half-years as well as in annual precipitation totals were specified as functions of the hemispherical characteristics. The latter in turn can be converted into time periods when the given hemispherical variable is expected to be reached in the process of global warming.

As an output of the first step of this approach, maps of temperature and precipitation patterns, corresponding to 0.5, 1.0, 2.0 and 4.0 K increases in the hemispherical mean temperature (likely scenarios by the end of the 21st century) are presented.

Regional effects of the global warming exert a fundamental and, at least in the first half of the scenarios, negative impact on the water budget of landscapes. This is one of the major environmental problems in many regions of Hungary, which may lead to conditions in which vegetation might not be able to reach the groudwater table. Moreover, a rapid degradation of soils may occur, especially in regions where droughts have been frequent recently.

THE EVOLUTION OF THE PANNONIAN LAKE (CENTRAL EUROPE) DURING THE LATE MIOCENE

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The Pannonian lake was formed, by the closure of formal marine connections, at about 12 Ma BP in the inner arc Carpathian basin. It occupied part of the Paratethys, a basin system formed in the Oligocene by the convergence of the Eurasian and African continental plates.

The early history of the lake was determined by lithospheric attenuation caused by extensional tectonics, due to late effects of the Carpathian subduction. Subsequently the subsidence became increasingly controlled by lithospheric cooling and the lake, originally having a complicated bay and island pattern,acquired a simpler shape. The evolution of the lake was accompanied by a sizeable tectonic to eustatic uplift of the neighbouring mountain systems, the eastern Alps, the Dinarids and especially the Carpathians. As a consequence, a high siliciclastic input, particularly from the northwest, subordinately from the northeast, induced a fast infilling of the lake by deltaic systems, but longshore drift remained a major factor in sediment distribution.

As a result of extensive seismic reflection studies reliable data are available about the internal structure of the basin fill. It is clear that in several subbasins the depth of the lake extended one thousand metres. Subbasins further from the delta systems remained stagnating for longer periods, here marls were deposited. By progradation the approaching delta systems caused turbiditic sediment transports. Finally, the deep subbasins were gradually filled in and transformed to delta and fluvial plains. The whole process was influenced by climatically controlled lake level variations of moderate size, most probably reflecting Milanković cycles.

The lake was endorheic for longer time periods, outflows became increasingly intense and frequent with time. Outflow was oriented toward the neighbouring Dacian basin, resulting in a limited spreadingof the endemic fauna and flora of the Pannonian lake. Reverse flow or associated faunal migrations have not been confirmed.

By the infilling of the Pannonian lake a considerable part of the Carpathian basin became a fluvial plain, at about the Miocene-Pliocene boundary. In a great part of the basin the formal subsidence stopped or even reversed into an uplift by early Pliocene times. This resulted in an erosion and redeposition of older lacustrine sediments. This process is well documented by mesa-like volcanic hills in western Hungary.

While a great part of the basin subsidence may be explained by stretch and subsequent thermal subsidence, additional evidencehas to be collected. Drastic changes in intraplate stresses might be proposed as an explanation.

COMPARATIVE STUDY OF GLACIAL FEATURES IN THE CARPATHIANS

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In the 1500 km long Carpathian mountain arc, glaciation occurred at different levels during the Pleistocene. The extent of glacial erosion and accumulation forms, snowlines during successive glacial periods, and dimensions of glaciers show significant variations.

Variation in size is assumed to have been caused by differences in location and aspect. This, combined with variation in rock types and other controls, has created the typical ice-formed features of the high Carpathian area.

The author conducted a study of the high Carpathian ranges as a whole, using data of field observations and of relevant literature and maps, focusing on Riss and Würm glaciation snowlines, extension of glaciers and glaciated areas, the distribution of cirques according to their exposition, and the altitude of cirque bases.

On the basis of measurements, using applied graphic methods of area representation including graphs, diagrams, 2-dimensional maps, and 3-dimensional simulated pictures, two distinct regions could be defined according to glacial geomorphology.

The northern region extends from the Western Tatra to the Căliman Mountains. The decisive factor in the glaciation process of this region was presumably the Saalian inland ice sheet having extended to the north, with its margin situated 40 to 200 kilometres from the glaciated mountains. This ice sheet, due to its cooling air and changing wind direction, had a major role in creating the variety of forms characterizing these high mountains. With the exception of the Western and the High Tatras, they display substantial differences between their northern and southern slopes, concerning the extent of glaciation, i.e. the region shows great variation according to exposure.

The southern region extending from the Tarcu to the Bucegi Mountains is characterised by a lesser extent of glaciation, smaller differences between features on the northern and southern slopes, and only a minor impact of inland ice sheet.

TIHANY VOLCANO AS A COMPLEX PHREATOMAGMATIC VOLCANO (PANNONIAN BASIN, HUNGARY)

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Detailed field observations, structural study and a review of the history of eruptive volcanism on the Tihany Peninsula extending into the Lake Balaton have been carried out with the purpose of understanding the evolution of both volcanic and tectonic structures. The Tihany Volcano which is more than 7 million years old (HARANGI *et al.* 1995, BALOGH K. 1995), and located in the central part of the lake basin, is formed by a series of basaltic pyroclastic formations. There are no lava flows but possibility of spatter cones is present.

The pyroclastic formations were produced by several successive pyroclastic surges and falls. The pyroclastic surge was mainly a base surge. The volcanic activity type was Surtseyan phreatomagmatism turning into predominantly Strombolian magmatic activity in the last phase. Field observations suggest penecontemporaneous phreatomagmatic and magmatic activity. The Tihany Volcano used to be a complex volcanic system with several eruptive centres, the main one being connected with phreatomagmatic activity and the corresponding eruptice centers.

The pyroclastic sequences contained an abundance of evidence testifying on horizontal displacement, as crossbeddings, dune-bedded layers, antidunes. The depth of explosion was calculated with the help of measurements of impact bombs and impact sags. The distribution of large country rocks indicate the main eruptive centers, and the changing of depth of explosion during volcanic activity. Five main eruptive centers and six main eruptive cycles were identified. The first four stages were of Surtseyan-type phreatomagmatic activity, and the final phase was of Strombolian-type activity. The tectonic and depositional characters indicate a maar-type origin of Lake Külső. The main volcanic structure of the peninsula is the Lake Külső. In our opinion it was a place of the initial phreatomagmatic activity, but the recent morphological view can be associated with the fourth explosive phreatomagmatic maar-forming stage.

The lapilli and coarse ash in the pyroclastic deposits are generally mud-coated, accretionary lapilli are common, and the tuffs are frequently light brownish, suggesting that the surges responsible for the deposits were wet.

TECTONICS AND GEOMORPHOLOGY OR: ARE THE STREAMS FLOWING IN THE RIGHT DIRECTION?

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The radially organized system of streams in the western half of Hungary has intrigued the geologists and geomorphologists for a long time. The theoretical centre is situated about 50 kilometres north of Bratislava, Slovakia, and the system extends as far as the Tisza River in the eastern half of Hungary. What has caused this remarkable geometry? A thorough analysis can provide us with a clue.

First let us have a look at the transport directions. We find that there are southward, northward and "randomly" flowing streams. The currents flowing in similar directions form blocks (5×10-20×50 km^2) and the "random" streams also concentrate in distinct areas. The most striking differences in the average transport directions can be noticed south of Lake Balaton where the average transport direction of the blocks changes gradually about 20 degrees clockwise from north to south. How can the differences be explained?

The original radiant system probably formed in the Early Pleistocene and consisted of streams flowing in S-SE direction. Later ridges started to rise, which locally changed the valley pattern but some of its sections were inherited over; these are the areas of the "random" streams. The basin of Lake Balaton started to sink in the Middle Pleistocene, which turned back the uniform southward direction of the streams south of the lake. At one stage west-east striking rivers (Kapos, Koppány) developed and again changed the flow of some of the water courses.

The clockwise rotation of the average transport directions and so the blocks indicates dextral strike slips along the curved lines of the rivers. The zigzag pattern of the rivers (especially that of the Kapos) and the small depressions at the bends of the zigzags also confirm tectonic influence.

The geometry of the drainage system tells us a lot about its origin and evolution. To answer the question in the title of this paper: yes, the streams always flow in the right direction only we have to listen to their stories to find out WHY.

SOIL PROPERTY VARIATIONS ON A THREE-DIMENSIONAL HILLSLOPE, SOMERSET, ENGLAND

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The importance of soil variations as a means of interpreting links between hydrological processes and pattern of hillslope evolution has been widely commented upon. However, little detailed progress has been made in measuring systematic variability of soil properties on three-dimensional hillslopes, and relating their distribution to present hillslope processes. This paper aims to find out the spatial significance of soil property variations on a three-dimensional hillslope at Bicknoller Combe in the Quantock Hills, Somerset, England. Research is initiated from two basic questions in soil-landscape studies: 1) what is the relative importance of horizonation and catenary redistribution processes in soil variations on hillslopes and 2) how much can soil variation be explained by quantified topographic factors.

Thirty three physico-chemical properties (n=486) have been regressed with environmental variables such as sampling depth, vegetation type and quantified terrain indices (elevation, slope, aspect, slope curvature, upslope area, etc.). The coefficient of determination (R^2) in each regression equation varies from 0.127 to 0.762. Despite podzolic soil differentiation and complex past pedogeomorphic subsurface features in the studied hillslope, more mobile soil elements (e.g. soil pH, exchangeable Ca, and Mg) show better systematic spatial distribution patterns. Most of the elements which show fairly good correlation (R^2>0.6) indicate that depth, elevation, concavity of slope, and slope gradient are important determinants of soil variations. The worse predictions mainly occurred for the physical soil properties (e.g. sand and silt content) and oxide content (e.g. oxalate extractable iron and "active ratio" of iron), which indicate relatively weak mechanical redistribution processes in the temperate climatic environment and complex catenary soil differentiation processes on the studied hillslope.

EVOLUTION OF GEOMORPHOLOGICAL SURFACES THROUGH PLATE TECTONICS, EROSION AND ACCUMULATION: THE CASE OF THE TRANSDANUBIAN MOUNTAINS (HUNGARY)

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The model described in the paper claims that the surfaces of planation once produced by some erosional process (peneplanation, pedimentation, pediplanation, etchplanation, Primärrumpf evolution) were reshaped in later geological periods by repeated erosion and accumulation on the morphostructure, also recurrently affected by tectonic uplift, subsidence and horizontal displacement.

In this model late Mesozoic tropical etchplanation with paleokarst and bauxite formation did not continue during the Tertiary in the Transdanubian Mountains of Hungary. As a consequence of multiple differential tectonic subsidence in variable thickness and at various intervals, most of the mountain range was buried under sediments. This burial was followed by three episodes (Paleogene, Neogene and Quaternary) of complete or partial exhumation. During repeated burial and exhumation the Cretaceous tropical etchplain was affected by further erosion or accumulation through non-tropical processes (such as peripedimentation, marine terrrace formation, alluvial fan accumulation and others). In the horst series of the Transdanubian Mountains, divided by graben-like basins, the position and geomorphic evolution of geomorphological surfaces allows the identification of some main types:

1) (semi)exhumed horst of etchplanation in summit position;
2) buried horst of etchplanation in uplifted position,
3) horst of etchplanation in threshold position, buried or exhumed and reshaped, mostly pedimented;
4) buried etchplain in basin position,
5) peripediments, rock pediments, locally buried under detritus.

The model of alternating erosion and accumulation for the evolution of geomorphological surfaces does not only apply to the Hungarian medium-height mountains, but also to numerous other geomorphological regions, e.g. the Alpine-Carpathian-Dinaric Ranges, several old mountains and massifs in Europe and on other continents.

CONSERVATION OF NATURAL AND ANTHROPOGENIC LANDSCAPES: THE EXAMPLE OF THE TOKAJ MOUNTAINS

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Landscape conservation as an applied discipline has developed in recent decades. In the nature reserves of Hungary almost invariably only single objects or landscape components received protection. (Most of them were rare plants or geological objects). It was first attempted in the Tokaj Mountains protected landscape that conservation was extended to cover all factors, to place the entire landscape under protection. Landscape conservation may refer to certain parts of the landscape, ie. the visual appearance, the aesthetic value of the landscape. In addition, the concept may include the conservation of geographical factors such as landforms, vegetation, geological objects and others.

In this respect the Tokaj Mountains presents opportunities unique in Hungary. In comparison to other mountains of volcanic origin there are several differences. They are due to the younger age of volcanic activity, a great variability of volcanic rocks and their geological positions. These special characteristics are not only apparent in geological micro- and macroforms, but also control the abundance of geomorphological features. Among the landforms the periglacial features are not matched by any other mountains in size and appearance in Hungary. The vegetation in the mountains is also extraordinary as in the north many Carpathian, and in the south many Pannonian elements have survived.

The protection is to be extended to the man-induced landforms in the mountains. They are remnants of earlier industrial and agricultural activities.

ACTUAL PERIGLACIAL PROCESSES IN HUNGARY

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The study of recent geomorphic processes is a major branch in geomorphology. On the one hand, the information gathered can help researchers to explain the recently evolved landforms and attribute them to various processes. Today these processes take place in a social environment and it is very common that the activities of the society generate them or enhance their efficiency.

The paper focuses on one of the recent geomorphic processes, on frost action. At a first glance, the importance of frost action does not seem to be particularly great in Hungary today. Author's experience gathered from several decades of research, however, indicate that - although the effects of frost are limited in time and intensity - this factor has to be taken into consideration in many areas.

Naturally, frost action in Hungary is only present in the winter half-year. Particular attention has to be paid to early frosts in autumn and the last frosts in spring. These are the intervals when freeze-and-thaw alternations (frozen conditions during the night and thaw during the day) are most frequent. Frost action is influenced by the mophological location, temperature, slope exposure and abundancy of water. The consequences of frost action are manifested in rock disintegration and removal of rock fragments from the surface. In loose materials (soils) the typical processes are frost heaving, frost cracking and mass movements on slope (gelisolifluction and various types of earthflows).

Finally, the significance of frost action as far as technical structures (eg. roads) also has to be appreciated.

GEOGRAPHICAL STUDIES FOR SYSTEMATISATION AND REGIONAL PLANNING: THE EXAMPLE OF THE ROMANIAN PLAIN -

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The Romanian Plain is the second largest of the 11 landscape units of the country. With an area of ca. 50,000 square km it extends to 21 per cent of Romania. With regard to industrial and agricultural production, urbanisation and transportation, however, it has primary importance. At the same time the Plain is a very complex region containing 10 types of morphogenetic units and it is also a kind of "coul de sac" opened toward northeast only with altitudes ranging between 5 and 400 m above sea level. That is why a need emerged for its systematisation and proper organisation. Accordingly, studies in the Romanian Plain has been based on the territorial systems methodology, field observations, geomorphologic mapping, demarkation of geomorphologic regions, quantification of the characteristics of geographic units, especially for the morphohydrographic (catchment) basins of lower, medium and higher order. The results of these studies led to the identification of very complex system-type relations between the different meteorological units (from very humid to dry ones), their natural and socio-economic impacts and to the elaboration of projects aiming at the management of these units.

Geographical studies for the systematisation of the Romanian Plain are based on the principle that modification of any component of the environment and implementation of any object must be in agreement with the equilibrium during the functioning of the system.

Ca. 40 system units have been identified and grouped subsequently into 11 genetic types with 6 varieties and specific indices or characteristics for each unit, type or subregion.

An analysis of water flow within the catchment basins was carried out simultaneously. Variations of the level of the watercourses taking their origin from the Carpathians and their effect on the Danube and Black Sea were monitored. Pollution sources (industrial and power plants, cultivated and urban areas emanating wastes) were identified. Regional studies were focussed on flood plains, foothills and slopes, loess and sand surface deposits, extensive alluvial fans, etc. The effect of irrigation systems, flood protection dykes, lake siltation was investigated, too.

The main purpose of the study was the establishment of a fair balance between the natural potential of and the growing human pressure on the Romanian Plain.

GEOMORPHOLOGICAL EVIDENCE OF NEOTECTONIC ACTIVITY IN NORTHWEST CROATIA

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The area under consideration is a mountain-basin macromorphological region as a part of Pannonian Croatia. In geological terms it belongs to the western border region of the Pannonian Basin in contact with ranges of the Alpine foreland. There is a special importance of the interrelation between the tectonic movements and genesis of geological structures and geomorphic processes. The paper deals extensively with transpression processes with the predominance of wrench faults.
The position and deformation of structural units as a consequence of global stress direction is also observed.Several types of structures are singled out, and they can be recognised as particular types of morphostructures. Examples of the most important relief characteristics are pointed out suggesting relationship between orography, geological structure and faults, the existence of a possible zone of extension and compression, the probable consequences of transpression processes, and the shift of certain parts of geological structures, especially transcurrent shifts.
The relief analysis covers detailed studies of drainage network, the shape and genesis of valleys, slopes, watersheds and terraces and their comparison with geological markers.

MORPHOGENETIC RESEARCH ON A JURASSIC SURFACE OF THE SOUTHWESTERN BÜKK MOUNTAINS, HUNGARY

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The faulted-folded mass of the Bükk Mountains belongs to the poorly studied structural-morphological units of the North Hungarian Mountains. The Bükk was moved by Alpine tectonic movements from a southwestern position to its present place during the Upper Cretaceous and Paleogene. A 2.5 square km model area was located around Imó-kő, in a microregion built up of less investigated Jurassic series. The research was aimed at contructing a morphogenetic model explaining all stages of mountain evolution. The area was studied from geological, geochemical, microtectonical, geomorphological, pedological, hydrogeological and climatic aspects.

The area has relatively homogeneous lithology. Its microtectonically mature shale forms a one kilometre wide pericline structure leaning northward. The harder pelagic limestone strata with flint lenses, interbedded in and folded with shale were exposed by differential erosion. They are resistant to erosion, impound water and produce abundant sediments influencing erosion and sedimentation, soil formation and hydrological processes, and determining the spatial pattern of plant associations within the area. Their thickest parts form "stones" whose deepest lying members accommodated seasonal overflow springs of the karstic waters stored in the caverns of the Bükk plateau. Three main genetic types of these "stones" can be distinguished: a) thrust valley ramifications, b) atectonic forms, c) tectonic structures running parallel with valleys. Their fracturing is more intensive than their dissolution, so karst development is subordinate producing microforms only. Due to slope categories and surface rocks part of the rainwater infiltrates (less than 6-8 per cent), another part (39 per cent) forms surface runoff as torrents in erosion gullies. The rapid and intense degradation of the easily fracturing rocks resulted in the formation of thin brown forest soil cover with rock debris and unfavourable water budget. Coenological investigations have proven strong correlation between surface rocks and species composition as well as between morphological characteristics and the inverse appearance of association patterns. Spots sensitive to disturbance were identified.

Having studied the relationship between the different features of the area, a model of surface forming processes was constructed which explains the dominant position of the components and which seems to be usable on similar type of Jurassic surface of the southwestern Bükk.

All kind of human activities should be restricted in the area because they lead to a rapid degradation of microfeatures, soils and plant associations.

FLUVIAL PROCESSES IN THE PEARL RIVER DELTA

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The Pearl River delta, with a well developed network of channels, was built up in an estuary of the West River and North River, as well as other water-courses at least 20,000 years B.P. Since then the land area has been increasing rapidly due to human impact such as the intense soil erosion along the upper course of the basin, continuous dyke construction in the delta area and land reclamation from the sea.

The main recent hydrological characteristics of the water and sediments in the Pearl River delta can be summarised as follows: 1) high discharge and medium tidal range; 2) extreme river regime with still considerable water discharge at low water stage; 3) small sediment concentration but large amount of sediments and 4) predominantly terrestrial sediment load and very little marine deposition.

The characteristics of the fluvial processes: 1) relative stability of the channel pattern and 2) "flood deposition" and "low water erosion" temporal distribution. On the long run deposition is becoming a basic tendency with an increasing amount of sediments from the flood plain of the river toward the tidal reach. According to the analysis of topographic maps of the 1950's and 1960's the total amount of tha material sedimented in deltaic rivers is ca. 22 per cent of the mean annual sediment load of the incoming rivers; 3) With the extension of the mouth the channel section tends to deepen and turns narrower gradually.

At present the Pearl River delta still extending towards the seashore due to an increasing rate of beach deposition.

Considering the dynamic factors and sediment sources of the Pearl River delta, the key problem is the implementation of control over water and sediment originating from the upper reaches of the Pearl River.

THE GEOMORPHIC ROLE OF SNOW PATCHES IN THE HIGH TATRAS, POLAND

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Quantitative studies of nivation processes were carried out on the northern slopes of the High Tatra Mountains, in the surroundings of Hala Gąsienicowa, above the timberline (1500 m a.s.l.) on the slopes developed on granite bedrock. Based on the results of this study, the geomorphic processes operating around the snow patches on the alpine slopes are presented.

The studies mainly concerned thermal conditions of weathering, meltwater runoff, material transport and the impact of snow patches on the accumulation processes developed on talus slopes. It is concluded that the key factor in the intensification of processes is increased moisture availability rather than the microclimatic effects of snow patches. If compared with weathering, present-day transport processes and deposition appear to be more active. Nevertheless, the activity of the above processes varies with the meteorological situation.

The geomorphological effects of snow patches on slopes mantled by and built of debris were analysed. Types of weathering covers, aspect, lithology and vegetation cover were taken into consideration.

Erosional effects are considerable on slopes mantled by debris devoid of vegetation cover. The niche backwall retreats 1 to 5 cm per year due mainly to frost action and needle ice. In the lower part of nival niche bottom sheet wash and rill erosion was observed.

On debris slopes "accumulation niches" are developing in places occupied by snow patches, most often in the apex part of the slope. They are formed due to accretion on debris slope free from snow cover in the vicinity of the patch when the surface under the snow is protected against both erosion and accumulation. Rates of accretion change from 0.0004 to 0.14 cm per year and depend mainly on the lithological conditions and on the aspect of the slope.

In general, effects and rate of nivation depends on slope type which mainly results from the lithologically controlled grain size composition of the cover.

In the High Tatras the most spectacular effects of the presence of the snow patches can be observed in the upper part of the debris slopes where nival accumulation niches develop. This brings about changes in the longitudinal slope profile.

Presently the role of nivation is restricted largely to the transformation of other landforms occupied by snow patches.

SOME RECENT IMPACTS OF RIVER CONSERVATION AND LAND DRAINAGE IN THE GREAT HUNGARIAN PLAIN

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In the wake of river regulation and flood-control measures the extremities of lowland rivers increased (high water levels rose and low water levels dropped); soil development on flood-free terrain took a different course and water deficit occurred over large areas. The largest rise in flood levels was observed on the Körös rivers (particularly on the White and Black Körös) and on the Szamos, where maximum water stage rises amount to 2 to 2.5 m. The corresponding value for the Upper Tisza and right-hand tributaries of the Tisza was less than 1 m. Since the period of large-scale human interventions on the upland catchments (reservoir constructions, transformation of land use pattern) is over in most areas, it could be concluded that there is no more change expected in the extreme values. A new factor, global warming, however, may intensify in the future and result in even greater extremities.

There is increasing evidence of global climate change in Hungary: a regional 'aridification' is observed on the Danube-Tisza Interfluve (recurring droughts in fifteen years); possibly regional damage in buildings in two areas of the Trans-Tisza Region and the extraordinary high water stages on the left-hand tributaries of the Tisza may also relate to this process. The agrometeorological evaluation of the impacts of warming has been done, but hydrogeographical aspects have not been given due attention. The seasonal and regional predictions of global warming count with considerable (up to 5°C) winter warming in the temperate belt. It involves that the share of rain grows in winter precipitation. This would lead to a more common occurrence of flood waves like the ones in late December 1995 and early January 1996 with higher water levels. The interannual distribution of precipitation may be modified for the benefit of the winter.

In order to understand how global warming increases the probability of such floods, the meteorological events of end of December 1995 were analysed. On the catchments of the Upper Tisza and left-hand tributaries of the Tisza a warm spell (with daily minima also above 0°C) led to the melting of 60-80 mm water in snow form. It was accompanied by abundant (locally 160 to 300 mm) rainfall. From a physical environmental aspect: in January weather turned drier and colder and the recharge of water stopped. From a social aspect: a great percentage of flood discharge could be retained in upland reservoirs and emergency reservoirs in Hungary were opened to accommodate surplus discharge. On Romanian territory, however, floods caused considerable damage and also in Hungary unprecedented water stages occurred along the border sections of the Körös rivers.

With a growing frequency of extreme discharges it seems doubtful whether the upland reservoirs will be able to cope with them. Global warming intensifies the extremities which emerged after river conservation. Precautions have to be made to avoid damage.

IMPACT OF BAUXITE MINING ON ENVIRONMENTAL MANAGEMENT

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The extensive economic development policy of the last decades led to environmental crises, to professional debates and to the eventual repugnance of the local population. The technology of bauxite mining in the Transdanubian Mountains was a typical and most prominent activity causing far-reaching environmental impacts and attracting peculiar attention during the economic transition in Hungary. The harmful effects of the mining lasting for several decades, displayed themselves in water and regional management and physical processes. It is time to sum up the symptoms of the slow improvement that can already be felt at places.

The main factor responsible for environmental degradation was the introduction of active dewatering technology in the exploitation of bauxite and coal in the region in the beginning of the 1960's. The sophisticated technology served the security of property and lives in the mines situated well under the karstwater table belonging to the 200 km long, 20 - 50 km wide karstwater system of the Transdanubian Mountains. The applied technology, however, caused an average 30 m dropping of the karstwater level. The karstwater depression had affected an area of 3000 km^2 by the turn of the 1970's and 1980's. It reached the lowest level (110 m) in the most important mining region in the W at Nyírád. Thus the depression was felt at the world famous and unique spa, Hévíz. Lake Hévíz is situated only 6 km from the SW basin of Lake Balaton. The balneological, medical, recreational and infrastructural value of Hévíz is incomperable. Many wells and springs of the region were dried out, including the most aboundant Hungarian spring at Tapolcafő. Karstmarshes got drained, and the 50 billion cubic m large water reserve of the region deteriorated. This aridification of the macroregion decreased both agricultural and sylvicultural potentials.

The exploited bauxite was transported by lorries to the alumina factory at Ajka. 800 thousand tons of ore was carried along a 20 km long public road section a year. Environmental pollution by the dust of the ore, the exhaust gas and the noise of the lorries locally exceeded health limits. Land use underwent major changes; farmsteads, croplands, forests were sacrificed for the sake of bauxite mining. Deep pits, spoil banks, spoil heaps have replaced them.

Due to academic reasoning and to the pressure of local authorities, the government decided to close down the deep-working bauxite mine at Nyírád. It was followed by the slow rising of the karstwater table, also in the Hévíz spa region. The pits and hollows resulting from mining are, however, still to be seen as there has been no recultivation of the area. Our work concentrates on mapping the landforms related to mining, and on detecting and evaluating the changes in micro-scale land use on the micro level before and after mining in the environs of Nyírád.

SOIL EROSION ON THE LAKE BALATON CATCHMENT

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The paper deals with the following problems:
1. assessment of soil loss in a tributary catchment of Lake Balaton as a function of relief, soils and land use;
2. measurement and calculation of (particulate and solute) sediment output from the catchment into the lake;
3. proposed land use change and measures to reduce the rate of erosion and thus promote sustainable development on the Lake Balaton catchment.

Investigations of the above problems are necessary and important because of the eutrophication and alkalisation of the lake. The increasing influx of phosphates and nitrates changed the former mesotrophic water into eutrophic and locally hypertrophic.

The Lake Balaton system consists of three different landscape units. A representative small drainage basin (that of the Örvényes Séd, area 24 square km) of the northern subcatchment was selected for detailed study.

The USLE was applied for the prediction of soil loss within the catchment. Rainfall simulation experiments were performed on various soil and land-use types in order to determine the K factor as precisely as possible. Plot measurements at the Csákvár Research Station were used as a control.

The measurements of sediment load and solutes at the outlet of the stream enabled us to compare the calculated soil loss from the catchment with actual sediment delivery into the lake.

Our investigations support the following statements:
1. The soils of the arable slopes of the Pécsely Basin are medium to strongly eroded.
2. Most of the soil deposit is removed from hillslopes, particularly from vineyards occupying the steepest slopes.
3. The overwhelming part of the eroded soil accumulates along footslopes within the basin and does not reach the stream bed at all. Sediment transport from the basins of the northern subcatchment is much less important than assumed before.
4. Solute (carbonates and sulphates) influx from the northern subcatchment, however, is considerable. Solutes derive from the karst system by natural solution processes. Land use has no influence on this source of natural alkalisation.
5. The following measures can be recommended to reduce the transport of sediment and phosphate: introduction of soil conservation techniques in vineyards; establishing an uninterrupted and wide permanent grassland strip on both stream banks to promote sedimentation.

MASS MOVEMENTS ON THE MUSCHELKALK SCARP IN CENTRAL GERMANY

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The lower member of the Muschelkalk, the Wellenkalk, is one of the principal scarp forming resistant caprocks in Hessen and Thuringia in central Germany. The Wellenkalk is underlain by clay, marl and gypsum of the upper Buntsandstein (Röt). When wet, the Röt forms a slip plane for the overlying limestones. Mass movements on the Wellenkalk scarp include falling, toppling, sliding, gliding and flowing displacements and combinations of the above processes. Investigations have focussed on the problem of detecting the spatial and temporal distribution of mass movement events. The spatial variables considered to control the dynamics on the scarp are the thickness of the caprock, the ratio between the thickness of the caprock and that of the softer substratum, lithology of the substratum, the degree of gypsum leaching, angle, direction of dip, exposure, height above the base level and ground plan position (re-entrant or projection of scarp). The impact of these control factors was studied and statistically analysed along some tens of kilometres of the Wellenkalk scarp.

Presently the occurrence of exceptionally heavy rainfalls sometimes combined with abundant snowmelt is assumed to be the most common temporal triggering mechanism of mass movements. It is still difficult however to judge if there were phases of increased or reduced mass movement activity during the late Pleistocene and Holocene and in historical times. This problem is owing to the scanty exact datings of the material affected by mass movements. Advance methods such as pollen analysis of material in slope hollows, dendrochronology and chronostratigraphic analysis are expected to yield a more reliable information on mass movement chronology. A better understanding of past and present events is a key for predicting the probability of the occurrence of future events.

ABOUT A SEMIDESERT AND DESERT CLIMATE IN THE CARPATHIAN BASIN DURING THE LATE MIOCENE AND EARLY PLIOCENE BASED ON DESERT CRUSTS

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There has been a long lasting debate about a dry-warm or hot semidesert climate in the Carpathian Basin following the total drying up of the Pannonian Lake. The "desert theory" was introduced by LÓCZY, L. sr. (1890, 1913) and CHOLNOKY, J. (1918).

Several geomorphological features were attributed to this period, eg. the basaltic mesas in the Little Plain and Tapolca Basin.

At the end of the Miocene, ca. 6.3-5.3 Ma BP., the climate suddenly changed into a semidesert or an almost desert one (Bérbaltavárium), indicated by the presence of fossils of extreme steppe elements as gazelles and *Epimeriones* (desert mouse) species.

These geomorphological features and mammal remnants were the only evidence for an arid to semiarid climatic phase. In absence of other proofs the existence of such a phase has been denied by many authors.

In several parts of the Pannonian Basin, eg. in Western Hungary or in the northeastern part of the Pest Plain red and reddish brown varnish-coated desert crust were found. These objects of several square cm size occur in sands situated at an elevation of 200-250 m a.s.l., which crop out in windows or are covered with red clays.

These crusts are very similar to those collected at Hassi Zegdou in Algeria. Thermoanalytical results are almost identical for samples from these localities. Siliceous desert crusts form under climates with a mean annual precipitation below 130 mm and a mean annual temperature between 16 and 24 °C The similarity of crust from Mogyoród (northeast of Budapest) with Algerian ones, varnish coated crusts, pebbles, and rootcasts in Hungarian sands prove the presence of a dry-warm or dry-hot period in the Carpathian Basin.

The sands yielding these crusts and rootcasts are capped with younger red clays. These red clays may help to determine the age of the crusts. The age of the *in situ* red clays is ca. 3-4.5 Ma BP. based on bio- and lithostratigraphical and paleomagnetic data as well as on their geomorphological position.

GEOMORPHOLOGICAL HAZARDS

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A geomorphic hazard results from any landform change that adverse effects the geomorphic stability of a site and that intersects the human use system with adverse socio-economic impacts. The hazard is commonly defined by geomorphologists as the probability of a change of a given magnitude occurring within a specified time period in a given area; the associated risk is the consequent damage or loss of life, property and services (VARNES *et al.* 1984). WHYTE and BURTON (1980), on the other hand, define risk as the product of the probability of occurrence of a hazard and its societal consequences. It both definitions, hazard and risk are connected: in the former the hazard assessment is central and is perceived as an objective scientific discipline; in the latter, the focus is on risks as societally evaluated phenomena, and the concept of risk supersedes that of hazard. Geomorphologists have made little contribution to risk studies, though engineers have recognised the importance of the field.

Geomorphic hazards occupy a central role in hazard assessment and new methods of hazard assessment draw heavily on satellite remote sensing and geomorphological survey. There is comparatively little discussion by geomorphologists of the limitations of geomorphic hazard assessment in isolation from societal goals and cultural value systems.

The risk approach to geomorphic hazards enables a fuller incorporation of both expert analysis and societal synthesis in the solution of the natural hazard problem.

GEOMORPHIC RESPONSE TO SHORT-TERM CLIMATIC CHANGES

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The climatic changes predicted for the nearest future are likely to trigger various processes which disturb surface stability. When estimating possible consequences two aspects should be taken into account: first, morphometrical and geological characteristics of the surface which control its sensitivity to climatic change, and second, spatial pattern of deviations of climatic parameters from their present values. The first information may be obtained from geological and topographic maps. The first approximation of the climatic parameters may be taken from scenarios for the cases of global warming by 1 and 2° C which correspond to Holocene and Last Interglacial optima (see Atlas of Paleoclimates and Paleoenvironments of the Northern Hemisphere, 1992). According to the scenarios the deviations from the present conditions were most conspicuous in Northeastern Eurasia (where mean annual temperatures may be 4 to 6° C above the present day values) and in the south, where a noticeable increase in precipitation could be expected.

The most susceptible to direct effects of warming are tundra regions of the northeast. Under these conditions permafrost easily loses stability which enhances erosion due to ice wedges melting out, marine erosion (the more so as the sea level would rise), earthflow and slumping.

According to the models, a less pronounced rise in temperature would occur south of the tundra zone; however it would hardly produce a noticeable response within forested areas. Unless the natural vegetation is seriously damaged, the predictable increase in precipitation (by ca. 100 mm per year) would not result in perceptible soil erosion. On the whole, the temperate forest zone can be considered as most stable under predicted climatic conditions.

The forest steppe and steppe zones seem to be more vulnerable. The erosion hazard strongly depends on the land use, especially on the ratio of arable land, and the value is extremely high in steppes and forest steppes of the southwest, where most considerable increase in rainfall is expected. High erodibility of soils in those zones is indicated by the amount of measured solid runoff which sometimes is ca. 70 tonnes per square km per year (according to DEDKOV, A.P. and MOZZHERIN, V.I., 1984). Under conditions of the present intensive land use, the predicted increase in rainfall (by as much as 300 mm annually) will result an increase in soil loss from arable slopes, probably by factor 2 or more, especially on loess, due to more active sheet wash and rill erosion, piping, gully erosion, etc. The eroded material can be partly redeposited at footslopes and on flood plains, the soil fertility may decrease by alluviation. Another result would be a rapid silting of water reservoirs. Dry steppes in the southeast of the Russian Plain will fall within the area of positive deviations of rainfall. The effect on soil erosion, however, may be negligible as arable lands are uncommon, and increase in humidity will probably result in denser vegetation protecting the surface.

SURFACE RUNOFF IN THE MYJAVA HILLS, SLOVAKIA

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The aim of this contribution is to characterise how the Myjava Hills are affected by surface runoff and to assess the present day and medium-term (time scale of decades) effects of these processes. Natural conditions and land use have made the studied area particularly liable to the above processes. Agricultural utilisation with large fields of collective farms and crop pattern unadapted to the topography with a frequent occurrence of dells, provokes detrimental effects caused by surface runoff.
The investigation of the geomorphic effects of runoff triggered by particular events (heavy rainfalls, snowmelt) was focussed on a detailed mapping of the spatial distribution of rills and of the soil layer washed down by erosion in relation to the topography as well to the type of cultivation. The medium-term effects were assessed on the basis of measurements of the thickness of the material accumulated since the beginning of the collectivisation in farming (from the 1950's to the present).
Based on the above investigations it has been concluded that
- processes of surface runoff show temporal and spatial variability due to their selective character in relation to land use and type of cultivation,
- landforms mostly affected by these processes are dells and dell-like valleys and the situation is further aggravated by an inadequate crop pattern (maximum thickness of the material accumulated in the bottom of dells during the studied period reaches 1 m),
- the effect of large fields formed in the course of collectivisation also displays spatial differentiation. It is much more manifest over large fields created by the merging and levelling the formerly terraced plots. Dynamics of surface runoff on fields of collective farms created by the merging of former plots did not show similar dramatic growth as these localities had suffered intense soil loss even before collectivisation.

This research was partly supported under Grant No. HRN-5544-G-00-2060-00, Program in Science and Technology Cooperation, Office of the Science Advisor, U.S. Agency for International Development.

THE VISTULIAN-HOLOCENE CYCLE IN THE EVOLUTION OF CARPATHIAN VALLEYS

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Climatic changes, tectonic factors and the human impact of the last millennium are reflected by the evolution of the Carpathian valleys. Several cuts and fills developed during the last glacial-Holocene macrocycle are observable while only some separate terrace steps are visible.
The interglacial floors usually are situated below the present channel of watercourses and only in the uplift zones they are located on higher rock benches. The last cold stage is represented by at least 3 to 4 fills, some of them interfingering with slope deposits or covered by youngest loess. The late Vistulian transformation of river channels was accompanied by erosion retreating upstream. Several fills reflect phases of higher flood frequency during the Holocene, followed by a trend to aggradation associated with afforestation. The study of longitudinal profiles of Carpathian valleys is very instructive showing both the coexistence of various factors and the retardation of changes along the upper reaches.

MORPHOGENETIC RESEARCH OF A LATE QUATERNARY SURFACE IN NORTHEASTERN HUNGARY

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Nearly 20 per cent of Hungary's surface is covered by wind-blown sand. One of the most important of these areas is found in the northeastern part of the country (Nyírség) having developed on a Pleistocene alluvial fan (SÜMEGHY 1944). The most frequent form on the blown sand surface of Nyírség is the parabolic dune type (Borsy 1991). Marshes of minor extension have developed in the depressions between parabolic dunes like the one enclosed within an asymmetric parabolic dune at Bátorliget and converted into a natural reserve. Here complex paleoecological and Quaternary geological investigations have recently been started.

After the analysis of the evolution of the Bátorliget marsh using sedimentological, palynological, geochemical and malacological methods (WILLIS *et. al.* 1995) 16 cores were deepened in an east-west cross section. This geological section traversed from the eastern wing of the parabolic dune to the western wing, thus the stratigraphic position and sediment structure of the different layers underlying the soil and marshy subsurface horizons have been studied in detail. The paleoecological and Quaternary geological results demonstrate that the main period of blown sand movement lasted until 18,000 years BP, when an increase in rainfall induced development of a soligenic and topogenic wetland around the parabolic dune. In the inner part an oligotrophic, cold water lake developed, the infilling of which started at the end of the pleniglacial and its character changed with the intensification of allogenic erosion, and with the enrichment of organic and carbonate matter during the late glacial/postglacial transition; a new lake phase began in the Early Holocene. At the late glacial/postglacial transition some index minerals (vivianite, goethite) formed in the sediment indicating environmental changes. The marsh phase started about 7,200 years BP, when human activity intensified (Willis *et al.* 1995) with growing erosion in a clearance zone. Based on sedimentological and radiocarbon analyses, after the Magyar Conquest (9-10th century) the central part of the depression was cleaned and the layers bear traces of human disturbance. This activity involving removal of some lacustrine layers in the central part of the depression stopped peat formation and induced the appearance of a new, smaller lake which was filled up in the last century.

PALEOECOLOGICAL RESEARCH OF THE LOESS ON THE KOPASZ MOUNT (TOKAJ, NORTH HUNGARY)

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Kopasz Mount (515 m a.s.l.) is located in the southern part of the Tokaj-Zemplén Mountains and built up of Miocene (Sarmatian and Pannonian) rhyolite and dacite. Its radial ridges constitute lava-flow profiles overlapping each other like rooftiles. These eroded lava flows and lava tongues were covered by loess during the Würm. Of the 16.4 square km area of Kopasz Mount, 12.8 square km is covered by loess. The loess mantled lava flows rise 120 to 150 m above the floodplains of the Tisza and Bodrog rivers. The length of lava tongues varies between 0.5 and 2.5 km, with widths ranging between 100 and 150 m.

These small "lava plateaus" are usually covered with a thick blanket (10-15 m, maximum 20 m) of typical loess while the slopes of lava flows are mantled by a 2-6 m thick loess. The typical loess contains two well developed paleosols. The loess-paleosol sequence was analysed by geomorphological, sedimentological, Quaternary malacological, isotope geochemical and geochemical methods. A number of charcoal remnants were found in the upper paleosol which were analysed by wood anatomy.

This charcoal-bearing horizon containing is located in similar stratigraphic position to other loess profiles of Kopasz Mount and its surroundings, and to some of the Hungarian key profiles (Mende, Püspökhatvan, Basaharc). The charcoal datings suggest that the area was covered by coniferous open forest and forest steppe vegetation during the formation of the paleosol with *Picea sp.* as the dominant tree taxa. The upper paleosol horizon of eight profiles was rich in charcoal fragments sufficient for radiocarbon analysis. Charcoals were dated to 26,000 to 29,000 years BP. Their high concentration indicate an extensive burning of woodland in the area in this time interval. Subarid continental conditions by the end of the interpleniglacial period combined with combustible vegetation types as *Picea* with some *Pinus silvestris* and grasses (taiga forest steppe or taiga open forest) could easily support a natural fire ecology.

Other results suggest the development of a podsol or podsol-like soil on the loess surface under this coniferous vegetation. This soil formation terminated ca. 25,000 years BP and dust accumulation and loess formation started. Quaternary malacological, sedimentological and geochemical data suggest a cyclic development of loess in this area and in the breaks of loess formation forests extended to the hillslopes while open vegetation declined.

SPATIAL ORDER OF LANDSLIDE PROCESSES IN HUNGARY

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The aim of this paper is to give a comprehensive overview of the areal distribution of landslide processes, based on the investigations of mainly geomorphological character carried out in Hungary for the last decades and on the author's field surveys and to present the density of landslide forms in Hungarian microregions using the data from previous cadastral surveys. Landscape types are selected and described have been those providing the most favourable natural conditions for natural (non-anthropogenic) landslide movements. The study examines and categorizes the landscape conditions for slides and draws a parallel between the occurrence of these conditions on the one hand and landslide activity and types on the other.

In the focus of these investigations have been hill regions built up of young, unconsolidated Tertiary sediments, riverside high banks and volcanic mountains, abundant in landslide forms.

As to the results, special stress should be laid on the distributional properties of landslide forms within the mentioned landscape types.

The landslide system of *hill regions* is demonstrated primarily on the example of Cserehát, a hill region in North Hungary studied by the author in great detail.

Based on surveys performed in the Hernád valley, a *river valley* with the most intense landslide activity in Hungary, relationships between the lateral erosion by the river and landslide configuration along the high banks were evaluated by mathematical-statistical methods as well.

Predominantly paleofeatures of *volcanic mountains,* having inadequately been studied before, can be found in groups on the valley slopes articulating the stratovolcanic structure, on the steep inner sides of caldera remnants and in the marginal zones of the volcanic series. Examples are demonstrated (Visegrád Mountains, Mátra) illustrating that slope evolution due to landslides occurring on the margins of the volcanic mountains resulted in a relatively narrow independent geomorphological zone, which can be easily followed in spite of its spatial discontinuity. The very existence of this landslide zone is a clear evidence of the essential role of these processes in the geomorphic evolution of mountains.

SOIL AND VEGETATION PATTERN IN RELATIONSHIP WITH MICRORELIEF (THE CASE OF HÁROS ISLAND, BUDAPEST)

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The "Háros Island" is a peninsula in the Danube section at Budapest, near Budatétény. Since the 1950's it has been closed to the public because of the military barracks established there. So in the recent past human impact has decreased, but the influence of the nearby industrial activities and of the previous forest clearing are still felt. The question is as follows: is there any relationship between the microrelief and the soil/vegetation pattern, and how is it manifested in the species composition of the indicator plants under natural and disturbed conditions?

In the Háros Island three subtypes of alluvial soil occur. In the high floodplain meanders calcareous humic alluvial soil and calcareous alluvial soil with a double humic horizon are found. One metre higher, on the high floodplain surface there is a meadow alluvial soil, indicating transition from alluvial soils to meadow soils.

The vegetation of the herbaceous and shrub levels display similarities to soil pattern. This is especially manifested in the early springtime aspect (in places not affected by forestry). In the higher areas youthful deciduous forest species prevail as far as species composition is concerned. In high floodplain meanders plants typical of the high floodplain, of the low floodplain and weed associations are present. Species of willow and weed associations advanced to the higher areas, affected by clearing. In the summer aspect the variation between the different areas remains, but the variance is less than in the early spring aspect, which can be explained by the decrease of the number of species. The share of the indicator species showing degradation is higher in the high floodplain meanders than the high floodplain surface as far as cover and species composition are concerned during the whole vegetation period.

In summary, the soil and vegetation patterns show similarities in their relationship with microrelief. Associations in the more elevated places are dominated by plants indicating natural conditions, while in meanders plants indicating disturbed conditions prevail. This might be attributed to the proximity of contaminated groundwater.

FIELD MEASUREMENT OF SOIL REMOVAL BY WIND NEAR KÖMPÖC (BÁCS-KISKUN COUNTY, HUNGARY)

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Wind erosion poses a serious problem in many parts of the world and is a dominant issue in Hungary too, where there are wind-blown areas of considerable size. These occupy nearly 20 per cent of the total surface of the country. Agricultural land most susceptible to wind erosion is situated in a large blown-sand area in the southern part of Hungary, between the Danube and Tisza rivers.

Wind blown sand areas play a considerable part in farming and their importance is ever growing. Thus it is apparent that conservation of light sand soils against wind erosion is vital. Geomorphologistshave to get involved in this research. Due to the studies performed in the last 30 years the knowledge on wind erosion has expanded, however up-to-date methods should be increasingly involved to extend investigations to new test areas.

The Department of Physical Geography launched an intensive research project on wind erosion in 1994. To investigate deflation occurring on the Danube-Tisza Interfluve a research station was located for measurements of deflation and accumulation of sandy soils, of meteorological and climatic conditions of wind erosion, and for sedimentological analyses of grains using electron microscopy.

Based on the data of a series of measurements lasting for ca. one year, period of the most intensive deflation have been specified (March-April). Correlation coefficients were computed between the meteorological parameters of the early spring months (daily precipitation and average temperature, wind velocity above the surface at 15-50-150 cm) and soil moisture. Out of deflation (maximum 7-8 cm) and accumulation (2-3 cm) figures measured in the research station the amount of the eroded soil (2-4 tonnes per hectare depending on land use) and also that of the accumulated material were calculated.

GEOMORPHOLOGY OF NEOGENE VOLCANIC MOUNTAINS IN HUNGARY

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The paper provides a short summary of the history of research on mountains of volcanic origin in Hungary, starting with J. CHOLNOKY's (1929) thesis (i.e. remnants of original volcanic landforms are typical) through B. BULLA's (1962) antithesis (volcanic mountains were eroded into planated surfaces with a rolling surface) to a recent synthesis by A. SZÉKELY (1982, 1989), which claims that volcanic mountains in Hungary have been eroded to various degrees, but volcanic forms controlled the erosion process and thus strongly influenced the present-day features.

The methods of investigation are outlined: a joint analysis of volcanic structures and landforms as well as the comprehensive and detailed study of drainage patterns. The latter are essential for the reconstruction of volcanic forms, since the initial drainage network was gradually superimposed on the erosion surface and consequently the main features of the original topography are still preserved. These remnants are important pieces of evidence. The drainage patterns of volcanoes of various type are presented and on this basis the direct and indirect influences of primary volcanic landforms on the present-day features are shown.

The three main stages of Tertiary volcanism in Hungary are described:

1) the resulting primary landforms,
2) the ways and results of volcanic reconstruction,
3) the rates of denudation, the nature of postvolcanic movements and their impacts on geomorphic evolution.

Detailed field surveys led author to the conclusion that in the volcanic mountains of Hungary the periglacial transformation of the relief during the Pleistocene - as a consequence of their structures - was much more extensive than elsewhere and these processes exert a decisive influence on the actual landforms.

Based on extensive comparative research in Hungary and abroad (in Japan, Eastern Africa and Mexico), author refers volcanic mountains into six groups according to the degree of their denudation and their transformation: intact volcanoes, truncated volcanoes, volcanic ruins, relict volcanoes, volcanic remnants and volcanic stumps.

SLAKING SUSCEPTIBILITY OF ROCKS AND HOODOO FORMATION IN THE DRUMHELLER BADLANDS, ALBERTA, CANADA

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Several hypotheses about the processes creating the mushroom-shaped topography called "pedestal rocks" or "hoodoos" have been propounded. These previous studies had mentioned the speculation based only on the field observations and had given little attention to the properties of rocks forming the mushroom-shaped topography. The present study elucidates the effects of rock properties on the formative processes of hoodoos. In the field and laboratory, the authors examined formation of hoodoos in the Drumheller badlands, Alberta, Canada, through measurements for several rock properties such as slaking susceptibility, pore-size distribution, clay mineral composition, core-penetration hardness and needle penetration hardness. Hoodoos, having a maximum height of ca. 3 m, are composed of three kinds of Cretaceous sedimentary rock types (sandstones and siltstones). Each hoodoo was morphologically divided into two parts: caprocks and pillar. Caprocks have a thickness of about 30 cm. A diameter of the pillar ranges from about 0.6 m to 2 m. Morphological characteristics of hoodoos correspond to difference of rock type. The caprock is made up of sandstone with a high resistance to slaking, while the pillar of both sandstone and siltstone with a low resistance to slaking. The difference of these three rock types in susceptibility to slaking stems from the combination of pore-size distribution and clay mineral composition, whereas these rock types had no clear difference in mechanical strengths represented by cone-penetration hardness and needle penetration hardness. These findings suggest that the formation of hoodoos in the study area is mainly controlled by the rock property for susceptibility to slaking.

CRYOGENIC FEATURES IN CANADA AND HUNGARY

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Permafrost distribution in Canada shows a latitudinal zonation. In its most southerly occurrence, permafrost is sporadic (Sporadic Permafrost Zone, SPZ), and is found mainly in peatlands as islands in a generally unfrozen terrain. Further north the permafrost is widespread and occurs in both organic (peatlands) and mineral terrain (Widespread Permafrost Zone, WPZ). In the most northerly regions all land surfaces, and even shallow water bodies, are underlain by permafrost (Continuous Permafrost Zone, CPZ). The main annual temperatures associated with these permafrost zones are 0° to -5°C (SPZ), -5.5° to -8.3°C (WPZ) and -8.3° to -17°C (CPZ). Patterned ground (e.g. circles, nets and hummocks) occurs to a lesser extent in the SPZ, but is very common in the WPZ and CPZ. Ice wedge polygons, a form of patterned ground, are very common only in the CPZ. Sand wedges that have formed during the Holocene period occur mainly in the northern part of the CPZ. Similarly, cryogenic soils are found only in wet, fine-textured materials in the SPZ, but they are dominant soils in the WPZ, and the only soils in the CPZ. In the CPZ cryoturbation is even found in cryogenic soils that occur in sandy materials.

Pleistocene deposits were examined in the Paks, Bábolna and Mogyoród areas of Hungary. In sand deposits near Paks two brownish layers, representing the B horizons of two distinct paleosols were identified, overlain by a thick sand layer on which the contemporary soil has developed. The B horizons of both paleosols are contorted and disrupted, and the B horizon of the lower paleosol is also dissected by a wedge-shaped sand body. Closer examination of these paleosols revealed strong mottles, suggesting that a fluctuating water table affected this horizon. Thin organic layers associated with what seemed to be a former vertical crack were also observed. All of these soil features appear to result from cryogenic processes. Various wedge-shaped features and sand involutions were examined in gravel deposits in the Bábolna and Mogyoród areas. Sand wedges, ice wedge casts and frost cracks filled with sand are commonly found in these gravel deposits. The average height of the sand wedges is 1.2-2 m, but some are as high as 3 m. The sand in these wedges is vertically layered, suggesting that frost cracking occurred a number of times, with subsequent filling of the crack with sand material.

Sand wedges, ice wedges all develop in permafrost environments, and are currently actively forming in the CPZ in Canada. Cryoturbated soils occur are most common in the WPZ and CPZ. Cryoturbated sandy soils, usually occur only in the CPZ in Canada. The well-developed sand wedges, frost cracks, ice wedge casts and cryoturbated soils found in Hungary suggest that the Carpathian Basin was most likely underlain by continuous permafrost during a cold, glacial part of the Pleistocene with main air temperatures as low as now occur in the CPZ in Canada.

TECTONIC LANDFORMS IN THE MALÉ KARPATY MOUNTAINS

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The major features of the West Carpathians emerged as a result of young tectonic movements. A number of studies have been devoted to this problem. However, the maps do not show the tectonic landforms in an adequate manner. An attempt has been made to correct this error by geomorphological mapping.

The young tectonic movements are manifested in particular spatial organisation of landforms which can be described by terms "line" and "grid network". The single line reflects certain spatial quality. Each landform (valley, crest, slope, foot line, saddle, etc.) lying along such a line possesses the orientation of the latter. Different landforms are unified by common orientation. The grid network is composed by several lines with different directions. The grid - a system of crossing lines - is a coherent spatial form. Many lines of the grid lie along geologically conform faults. This spatial coherence is substantiated by the tectonic origin. Grids consist of faults, joints and mylonitic zones. In the souther part of the Malé Karpaty Mountains the grid is very dense with almost each type of landforms.

VALLEY FLOOR MORPHOLOGY AND LITHOLOGY AS INDICATORS OF LATE PLEISTOCENE CLIMATIC CHANGES

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A detailed geomorphological mapping carried out in central western part of Belgium allowed us to investigate the valley morphology of three major rivers of the country (Lys, Scheldt and Dender). Significant differences in their present-day morphology as well as their buried paleomorphology refer to late Pleistocene climatic events and changes.

The present-day flood plain occupies just a small part of the total valley floor built up by annual inundations. The alluviation, having mainly occurred since Roman times is obviously due to human deforestation and land cultivation and not to some climatic change.

The main part of the three valley floors is occupied by a low terrace, however covered by thick Weichselian loess of conspicuous morphology. Below, over several kilometres of width two fluviatile lithotypes are superimposed, testifying on two different kinds of climatic conditions during the first part of the Weichselian. Above them traces of a Weichselian interstadial have been found. Underneath the Weichselian fluviatile sediments a narrow and deep river channel is infilled by Saalian fluviatile deposits.

From the Late Glacial evidences of marked fluvial erosion and accumulation as well as of cryo-eolian accumulation have been found. Among them one and in some places two very low terrace levels are associated with the Late Glacial and with the transition to the Holocene.

SPATIAL ANALYSIS AND MAPPING OF THE THICKNESS OF COVER SEDIMENTS IN THE LITTLE PLAIN, HUNGARY

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The Quaternary aquifer of the Kisalföld (Little Plain) is one of the largest freshwater resources in Central Europe. From the geomorphological viewpoint it is built up as the alluvial fans of the Danube and Rába rivers. In large areas the sandy and gravelly water-bearing deposits are covered with a (semi-)confining layer with finer structure. This cover layer has a great effect on the groundwater recharge and evaporation processes in the region, therefore, it is important to have an accurate knowledge about the spatial distribution of its thickness. A geostatistical study was carried out to evaluate the reliability of the existing data set on the thickness of the cover sediment and to elaborate the most suitable method of mapping. Based on statistical analysis it was shown that the available data set represents the variations in the thickness sufficiently for regional studies. Moving window statistics and variogram analysis revealed differences between the spatial characteristics of the cover layers of the Danube and Rába alluvial fans, which might be attributed to the differences in the mechanism of deposition. The thickness data were therefore mapped separately for the two alluvial fans. From the variogram analysis it can be concluded that, although the regional variance of the cover sediments is represented sufficiently by the available data, the short range variations cannot be fixed by the existing density of observations. They can be derived eg. from surrogate data, like aerial photographs, which can help the determination of observation points for further analysis.

KARST PROCESSES IN NORTHERN BAKONY MOUNTAINS

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In the paper karstification is divided into surface and subsurface processes.
Karstification on the surface is either syngenetic or postgenetic and affects a covered karst in the studied area.
During syngenetic karstification vents are produced in the karstic rock and simultaneously swallow holes appear on the surface of the cover sediments. Syngenetic karstification takes place over the elevated parts of an uneven karstic basement. Here, as a consequence of their rapid removal from the surface, cover sediments are thinner or karstic masses are even exposed. Consequently, conditions favouring karst processes can occur in the following positions:
1) Along fault scarps, where cover sediments are easily stripped off through sheet wash or stream erosion. In the first case karst landforms develop on interfluvial ridges, while in the latter on valley floors.
2) Cones of karstic origin may also be stripped from cover sediments through sheet wash or stream erosion. Sheet wash may affect tilted or non-tilted blocks. In the latter case the sides of the exhuming blocks or the cones covered in the interior of covered karst terrains show karst features. In areas of covered karst subsurface material transport results in closed features. The valleys produced by stream erosion may be aligned along the strike of cone series or may be different. In the first case, valley sides, while in the latter valley floors are affected by karstification.
3) Margins of paleokarstic hollows or, in the case of thresholds, the interior parts are affected.
During postgenetic karstification karst features develop in the cover sediments through collapses due to the reactivation of earlier developed passages. Postgenetic karstification is mostly associated with the exhumation of ponors along the rock contact zones on the floors of superimposed valleys.
Underground hollows produced by karstwater flow may develop in the vicinity of the buried calcareous surface or below intensively incising superimposed valleys. In the first case, hollows with thin ceilings cave in and collapse dolines come about. In the latter case, however, they are either consumed by valley incision or open up and form cave remnants in valley sides.

GEOMORPHOLOGICAL ASPECTS OF THE HUASCARÁN ROCKFALLS (PERU)

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The Cordillera Blanca Mountains, as a part of the Peruvian Andes, is a young mountain range with a high degree of seismic activity and with an intensive valley and highly developed erosion network, involving slope instability. The Callejón de Huaylas (Santa River Valley) and adjacent slopes of the Cordillera Blanca Mountains have been affected by several natural disasters, the most devastating being an earthquake and consequent slope movements which took place in 1970. As the whole region is relatively densely populated, the problem of the assessment of risk levels has gained importance. There is an evidence that during the period before the Spanish invasion the Huascarán was the scene of a more extensive rockfall than those registered in the 20th century.

In the place where the Ranrahirca River flows into the Callejón de Huaylas, the Santa River abruptly changes direction turning southeast toward the neighbouring mountain ridge called Cordillera Negra. It is very probable that long time ago the Santa River was "pushed away" by a huge amount of sediments from the Huascarán situated on its left bank. It has already affected the straight section of the Cordillera Negra foreland. The new centre of Yungay town seems to be situated outside the reach of possible avalanches from the Huascarán. The settlement spreads ca. 2 km northwest of the former town and is protected by a smaller hill in the foreground of the Huandoy Mountains. Nevertheless, the southeastern margin of Yungay is endangered by a considerably larger rockfall from the Huascarán and, in addition, the overspill population of the expanding Yungay have settled along the margin of the once destroyed area. In 1995, twenty five years after the most serious recorded natural disaster in the history of the country, a new school was opened immediately on the mud flow accumulation.

ENGINEERING GEOMORPHOLOGY AND URBAN DEVELOPMENT IN SZEKSZÁRD, HUNGARY

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Szekszárd is located in internationally recognised wine-producing region in southern Transdanubia. The town lies on the eastern margin of the Szekszárd Hills of 200 m altitude. The hills are built of Uppermost Miocene (Upper Pannonian) aleurolite, mantled by thick loess on the summit levels. In the steep slopes clayey paleosols are exposed in the loess sequence and this presents a landslide hazard. Most of the town is built on these slopes. Therefore, engineering geomorphology has numerous tasks to solve in the area. The problems spring from two sources:

1) Urban expansion takes place at the expense of previous vineyards. The wine-cellars carved out of loess present an obstacle to constructions. Heavy vehicle traffic on roads built above them may lead to collapses.

2) The outcropping paleosols and Upper Miocene strata favour the development of slip planes for landslides.

For the above reasons, new housing developments with multi-storey buildings took place at footslopes. Even there mass movements endanger residential areas.

The major tasks of engineering geomorphological investigations is the mapping of the extension of movements over paleosols and Upper Miocene strata, the analysis of their causes and the description of their mechanisms.

GEOMORPHOLOGY AND URBAN WATER PROTECTION AND RECREATION ZONES (THE CASE OF MINSK, BELARUS)

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Along with hydrological analysis, a geomorphological study is one of the primary approaches to allocate zones of water protection and recreation within the confines of urban areas. As a first step morphological features and quantitative (morphometric) characteristics: absolute elevation, vertical and horizontal dissection, length and steepness of slopes should be studied. These five characteristics define intensity and direction of surface runoff, traceability and visibility of the area, its illumination conditions and aesthetic value, the latter being of particular significance for recreational use.

Geomorphological analysis begins with the delimitation of catchments of watercourses draining the areaexamined. Then plans of the drainage network within the confines of the catchments are to be prepared using the schemes of vertical and horizontal dissection. The more dissected the relief is, the more exactly defined is the drainage network and the higher is the energy (erosional-accumulational) potential of the relief. The valley-ravine network concentrates surface runoff, especially when talwegs have no hanging valley issues. Direction and intensity of surface runoff are affected by the presence of vegetation cover and by the development of urban infrastructure. Urban road layout tends to intercept and dissipate surface runoff and streets often follow the pattern of talweg network turning into streams during heavy rainfalls.Urbanisation affects the geomorphological features of areas to be developed (smoothing, terracing, levelling) however the general trend of geomorphological processes is inherited even in urban areas.

Geomorphological analysis has demonstrated that in Minsk ca. 30% of the territory should be converted into water protection zones and ca. 25% of the latter could be used for recreation purpose.

KARST DENUDATION CALCULATED FROM KARST MORPHOLOGICAL SOIL EFFECT

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Lime solution capacity of infiltrating water, characteristic of the soil itself, is due to a number of soil processes. Limestone solution capacity (corrosion capacity) is also characteristic of the soil and expressed in relation to the amount of infiltrated water: this figure is normally much higher than that of the solution capacity of rainwater.
The analyses produced the following figures for the research field (partial data are neglected):
average aggressive CO_2 content of rainwater is 0.278 mmol per litre and
average aggressive CO_2 content of infiltrated water before lime solution is 2.092 mmol per litre.
The aggressivity of the remaining part of infiltrating water is able to solve 12.71 g per square m of limestone a year. This conditional lime solution capacity is defined as potential lime solution capacity.
This figure for karstic corrosion represents the average quantity of limestone loss in the research area by solution processes near the sub-surface. The collection of many measuring data a lot of years gives an opportunity to draw a map a theoretical paleographical situation.
The value of complete average limestone solution capacity - calculated to limestone denudation - is 0.01065 mm per year, ie. ca. 10 mm per thousand years.
The average complete solution of chemically neutral or slightly acid karstic soils is 26.65 g per square m per year or 260 kg per hectare.

MONITORING RECENT KARSTWATER INFILTRATION

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A monitoring system has been installed in the Aggtelek Karst in Hungary to study the process of karstic infiltration. This system is equipped with sensors and loggers and continuously measures the parameters of the infiltration from the surface down to the karstwater table.

The units of the measuring system are located in karstic vadose and epiphreatic zones along a vertical section. The first unit (which measures precipitation) is above the surface, the second unit (which measures run-off) is on the surface. Five seepage measuring units were installed in the thick soil accumulation at 0.5, 2.5, 5.0 and 8.5 metres. Finally, two units measure the infiltrating water of the ceiling of the Béke Cave, directly at the level of the karstwater table.

Until the humidity of the top 5 cm soil layer reaches the level of 92-93 per cent, and precipitation does not exceed infiltration capacity is higher than the, all rainwater infiltrates. Runoff starts at 92-93 per cent humidity value.

In forested areas infiltration occurs 1 to 12 hours later than on grasslands. The rate of the downward movement of the infiltration front depends on the initial level of water saturation of the soil.

The rate of infiltration process increases with depth, but certain rhythmical changes in the intensity can be observed in the vicinity of the karstwater table.

Changes, occasionally periodicity, in the intensity of seepage at various depths can be most easily explained by lunisolar effects, which have already been proved to control movements in karstic hollows.

Measured data of karstic infiltration gave the opportunity of calculating the average value of limestone solution.

CHANGE IN NATURAL ZONATION AS REFLECTED BY THE EVOLUTION OF RED EARTH IN CHINA

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In this paper a discussion is presented on the location of natural zones (northern and southern portions of subtropical as well as tropical zones) in China during the four warm periods since the late Pliocene based on the spatial and temporal distribution of the brown reddish soil, red earth and relict mottled red clay. Changes of the limit of natural zones in four areas of China can be instrumental in the reconstruction of climatic variations and their amplitudes.

The northern limit of the northen half of the subtropical zone were 41~42°N, 46°N, 42~45°N and 35~40° during the warm periods of N_2, Q_1^2, Q_2^1 and $Q_3^1Q_3^2$, respectively; 35°N, 36~42°N, 33~34°N, 30~33°N for the southern half of the subtropical zone; and 25~32°N, 30~32°N, 25~30°N and 24~26°N for the tropical zone.

Comparing with the present day situation the boundary of the northern part of the subtropical zone showed the maximum extent of northward shift (by 6~13°) but the other two zones experienced a similar amplitude of displacement during the four periods in concern.

The extension of three kinds of red earth during the Q_1^2 was the northernmost one (by 12~13°, 8~12° and 5° shifts for the warmest period) during the Quaternary in China.

Comparing climatic conditions of the four warm periods of the Quaternary with the present day ones 3~5° C higher mean annual temperatures and 300~500 mm more annual precipitation are assumed to have occurred.

In North China and along the middle and lower reaches of the Yangtze River profound environmental changes might have taken place particularly during the Q_1^2 with a variation of two natural zones, while Central China was an area of the confrontation between the subtropical and tropical zones; however, South China has always belonged to the tropical zone.

The northern boundary of the tropical zone moved to 30°N during the three time periods in concern so Southeast China fall into the tropical zone for a long time causing extensive development of relict mottled clay, particularly during Q_2^1.

Until the late Pleistocene Central and East China belonged to the southern part of the subtropical zone, thus the present tropical and red earth distribution developed.

PROGNOSES AND RAPID CHANGES OF THE CARPATHIAN RELIEF DURING DISASTROUS FLOODS IN THE LAST 50 YEARS

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During the last 50 years there were four disastrous floods (in 1958, 1960, 1970, 1980) in the Carpathians. They caused great changes in relief and damages in economic infrastructure within the reach of high water. Gradually increasing precipitation does not influence the balance in the beginning. After exceeding a level of balance even the smallest increase in precipitation triggers intense processes. Experts pointed out that the threshold value of landscape stability depends not only on the critical amounts of precipitation but mainly on the rhythm of the proceeding rapid rainfalls affecting the height and course of flood waves. Similar size of disastrous rainfalls (exceeding mean annual precipitation by 28-30 per cent) with different rhythm of the proceeding rainfalls involve various types of relief modelling. For some of the processes (eg. erosion) the threshold value of the slope stability is exceeded while that for other geomorphic processes (eg. landslides) is not necessarily reached.

Studies on the siltation of water reservoirs in the Carpathians showed that during the period between the above floods ca. 93,750 cubic metres of material was deposited annually i.e. 85 cubic m from each square kilometre of the partial catchment basins. During the flood in 1958 ca. 1 million cubic m (ca. 1000 cubic m per square km) was deposited. From the amount of material removed from the catchment redeposition cannot be estimated within the basin since a great part of rubble does not reach the reservoir but fills up the middle and upper parts of the valleys. In the Carpathian sections of the catchment basins ca. 12,000 cubic m of rubble was transported from 1 square km.

Long-term observations of floods show that during disastrous rainfalls the threshold value of relief modelling is exceeded and the precipitation and water levels are close to absolute maxima. In spite of exceeding the stability limits, relief modelling can be different in the same mountainous regions and six scenarios of relief modelling can be distinguished during extreme floods.

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